THE PUBLIC MILK SUPPLY

Hugh A. Macewen

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See page 183

THE PUBLIC MILK SUPPLY

BY

HUGH A. MACEWEN

M.B. CH.B.(GLAS.) D.P.H.(LOND.) D.P.H.(CANTAB.)

Assistant Medical Officer of Health for Cumberland
Late Resident Physician, Belvidere Fever Hospital, Glasgow
Late Lecturer on Hygiene, Cooper Medical College, San Francisco

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PREFACE

The Public Milk Supply is of such great importance that no excuse for a book on the subject is necessary. Pure and wholesome milk is an ideal form of nourishment which it is difficult or impossible to supplant by any other form of food. Milk that is contaminated may, however, be directly responsible for the propagation of many of the commoner infectious diseases. The findings of the Royal Commission on Tuberculosis, who state in their Second Interim Report that "a very considerable amount of disease and loss of life, especially among the young, must be attributed to cows' milk containing tubercle bacilli", clearly indicate that tuberculosis is also frequently conveyed in a similar manner. The existing conditions under which milk is produced are, in too many instances, far from satisfactory, and it is probable that in the near future, either as a result of fresh legislation or otherwise, a marked improvement will be called for.

The author, having had exceptional opportunities of becoming familiar with the practical side of dairy farming, has attempted in the following pages to show what a satisfactory milk supply should be, and how it may be obtained. Much useful information has been

derived from literature on the subject, from expert Farmers and Dairymen, Medical Officers of Health, Sanitary Inspectors, and others, the source of such information being acknowledged in the text. The author desires also to acknowledge his indebtedness to the Board of Agriculture and Fisheries, Dairy Supply Company, Lumley & Co., and Mr. Barr, for their kind permission to use certain illustrations.

It is hoped that the book may prove useful to all interested in the milk trade, more especially to Medical Officers of Health, Sanitary Inspectors, and others who are responsible for its administrative control. It is believed that this volume, together with *Food Inspection*, written by the same author, and recently issued by Blackie & Son, Ltd., contains all the information necessary for those working for the Food Inspector's Certificate of the Royal Sanitary Institute, the Incorporated Sanitary Association of Scotland, and other bodies. An Appendix on Cereals, Beverages, Condiments, &c., has been inserted for the benefit of such students.

H. A. M.

May, 1910.

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PART I

Milk as an Article of Commerce

Milk as an Article of Commerce

Sale of Milk Regulations—Percentage of Fat contained in Milk—Factors influencing the Quality of Milk: (1) The Breed of the Cow; (2) Age of the Cow; (3) Period of Lactation; (4) The Effect of Food; (5) Time and Method of Milking; (6) Daily Variations; (7) Seasonal Variations, &c.—Unfortunate Wording of the Regulations—Method of Retailing Milk—Colostrum or "Beastings"—Manipulation of Milk—Manner of taking Samples under the Sale of Food and Drugs Acts—The "Appeal to the Cow"—Vendors' Excuses for the Poor Quality of their Milk—The Use of Chemical Preservatives.

The Sale of Milk Regulations issued by the Board of Agriculture in 1901 lay it down that—

1. Where a sample of milk contains less than 3 per cent of milk fat it shall be presumed, until the contrary is proved, that the milk is not genuine, by reason of the extraction therefrom of milk fat, or the addition thereto of water.

2. Where a sample of milk contains less than 8·5 per cent of "solids not fat" it shall be presumed, until the contrary is proved, that the milk is not genuine by reason of the abstraction therefrom of "solids not fat", or the addition thereto of water.

3. When a sample of skimmed or separated milk (not being condensed milk) contains less than 9 per cent of solids (including fat), it shall be presumed that the milk is not genuine.

Percentage of Fat contained in Milk.—There is much difference of opinion as to the degree of variation which may—apart from adulteration—occur in the percentage of fat contained in normal milk. Many farmers maintain that the milk of certain cows does not contain as much as 3 per cent of fat, and that the composition of the milk of all cows may vary

under different conditions. A large number of investigations undertaken in connection with this important subject have given conflicting results.

In the *Transactions of the Highland and Agricultural Society* may be found the results of investigations conducted under the supervision of Mr. Speir, of Newton.

During the year 1904 there were 320 cows under observation in Ayrshire, 363 in Dumfriesshire, and 648 in Wigtonshire. Of the 320 cows in Ayrshire, 3 gave an average milk fat below 3 per cent. Of the 363 in Dumfriesshire, 2 gave milk fat below 3 per cent. Of the 648 cows in Wigtownshire, 21 gave a milk fat below 3 per cent.

In 1905, 391 cows were kept under observation in the Maybole district, and 6 of them gave a milk fat below 3 per cent.

In 1906 the records of 372 cows in Cumnock district, and 443 in Fenwick, are given in the *Transactions*; only 1 cow in the former and 2 in the latter gave an average milk fat below 3 per cent.

Mr. Dunbar, in the *Seventeenth Annual Report of the County of Dumbarton*, states, in connection with a series of experiments conducted by him, that, "notwithstanding the fact that the six cows calved within twelve days, and for a great portion of the milking period received abnormal feeding" (intended to produce quantity rather than quality of milk) "only on fourteen occasions during 333 days was the morning milk below 3 per cent of milk fat. The evening milk was above 3 per cent on all occasions."

The author had a byre of six cows under his own personal observation and control. On analysing the morning and evening milks for a considerable period of time it was found that one of the animals frequently, though not always, yielded milk containing less than 3 per cent of fat; though that given by the other cows, fed and housed in an exactly similar manner, contained fat very considerably in excess of that amount.

Factors Influencing the Quality of Milk.—There seems little

doubt but that the district in which the cows are kept has an important influence on the quality of the milk; the other factors may be summarized as follows:—

1. *The Breed of Cow.*—The breed of cow has an important bearing on the quality of its milk. Thus the milk of Jersey and Guernsey cows is rich in fat, the latter being present in the form of large globules which readily rise to the surface. Dairy Shorthorns give a comparatively large milk supply of good average quality. The milk of Ayrshire cattle contains a high percentage of casein and a fair percentage of fat. Dutch cows usually yield an abundance of milk with a low percentage of fat. The milk of individual cows of the same breed varies considerably; thus there are those that give milk rich in fat, and also those whose milk has a percentage of fat below the average of the breed in question.

2. *Age of the Cow.*—Old cows generally give inferior milk; the mere number of calves that a cow has had seems to have little bearing on the quality of its milk.

3. *Period of Lactation.*—It is supposed that the quality of the milk of any cow undergoes considerable change, according to the period of time that has elapsed since calving. Many believe that the milk of newly calved cows is poor in fat for two to three weeks after calving. It is probable that individual cows differ in this respect, and that no general statement can therefore be made. Mr. Dunbar holds "that there is no fixed course of production of quality or quantity in any cow immediately or soon after calving, and that one cow may give considerably over 3 per cent of milk fat and another below it".

4. *The Effect of Food.*—The effect of food on the quality of the milk is very marked. Foods rich in carbohydrates—mangolds, beetroots, &c.—increase the amount of sugar in the milk; they also tend to increase the quantity of milk produced. A nitrogenous diet increases the amount of casein, and probably to a lesser degree the fat also. Cows fed upon large quantities of refuse from breweries and distilleries generally yield an abundance of milk poor in fats and other

solids. Indeed it may be said that any method of feeding which largely increases the quantity of milk generally, at the same time, reduces its quality. It is the practice of some dairymen to give their cows much salt along with their food in order to make the animals thirsty, and thereby increase the quantity of their milk at the expense of its quality by reason of the large amount of water which they consume. Such a practice, which is little more than watering the milk through the mouth of the cow, cannot be considered legitimate. Again, even without giving salt, if the food be sloppy and contain much water, or if an excessive number of turnips—which are composed of about 90 per cent of water—be given, the flow of milk is much increased, and its quality correspondingly decreased.

With regard to the effect of grass on the quality of milk there is much difference of opinion. Thus some hold that when cows are first put out to pasture, after being stall-fed during the colder part of the year, there is an increased flow of milk and a consequent lowering of quality; whilst others state that, for the first three to four weeks after cows are put on to grass, there is a marked improvement in the flow and also in the quality of the milk. Such discrepancies may probably be explained by the fact that much depends upon the quality of the pasture as to whether the milk will be improved or otherwise by the change.

It is a common belief that odours and flavours pass from the food of the cow into the milk. It is said that the milk of Alpine cows is noted for its aromatic taste. We know that milk frequently possesses a turnipy flavour, a fact that is usually attributed to the cows eating turnips. It is probable that in some cases this is the true explanation, but it has been recently shown that such a flavour may be due to the growth of a particular bacterium (*B. lactis fœtidus*) in the milk. If the taste is due to the turnips eaten by the cows, it will be present in the milk immediately after milking. If, however, it is absent from the new milk, and does not develop until several hours after the milk has been drawn, it must be due

to the growth of micro-organisms, and may be got rid of by enforcing greater cleanliness.

5. *Time and Method of Milking.*—It is a well-known fact that the milk yielded by a cow in the morning almost invariably contains less fat than that yielded in the evening. This variation in the quality of the milk, as regards fat, may be largely accounted for by the difference in the interval of time which elapses between one milking and another, because it is found that the longer the interval the greater is the quantity of milk and the lower is the percentage of fat and solids which it contains, and vice versa. The influence of the amount of food and drinking water taken by the cows during the night may likewise be considerable.

The method of milking also affects the quality of the milk. Thus the "fore milk", or that shed during the first part of the milking, is deficient in fat, while the "strippings", or that last removed from the udder, is very rich in that substance. It is, indeed, the case that, if milk be drawn in successive portions, the percentage of fat will be found to rise steadily from the first to the last. Hence a good average milk can only be obtained if the udder is entirely emptied, and the whole milk well mixed.

If the milking is done by a strange or inexperienced person, small differences in the quantity and quality of the milk may result.

6. *Daily Variations.*—It has been clearly established that not only the quantity of milk which a cow gives, but also the percentage of fat which it contains, is subject to daily variations. Thus a cow may yield a milk containing 3·2 per cent of fat one day, and only 2·8 per cent on the next. The reasons for these daily variations are not yet understood; changes of food or the times of feeding or drinking certainly exert an influence, yet very often it would appear that such variations occur without external causes.

7. *Seasonal Variations.*—There is considerable difference of opinion as to the periods of the year during which milk may be expected to be deficient in fat. Richmond states

that in February, March, and April the fat becomes less in quantity; while in May, June, July, and August the fat is low, though there is a tendency for it to rise at the end of that period. Dunbar says: "That the investigations described do not in the case of any individual cow support the contention that where a cow is kept under normal conditions, and receiving rations with proper constituents, she will produce milk below 3 per cent of milk fat in any particular season of the year".

From what has been said above, it will be seen that the question of the variation in the composition of milk, and more particularly in the percentage of milk fat which it may contain, is a very complex one. It is probable that where a number of cows are kept, and where the milk of all the cows is mixed together, variations in composition which any individual cow may exhibit will be counterbalanced by the excess of fat, over and above the 3-per-cent standard, which the other cows are almost certain to produce. Where the milk is derived from a limited number of cows—especially if from one or two—the result may be very different.

Unfortunate Wording of the Regulations.—In any case the wording of the Regulations of the Board of Agriculture (given at the commencement of this section) is unfortunate, because it implies that if a farmer or dairyman sells a milk containing less than 3 per cent of fat he has been guilty, not merely of offering a milk of poor quality for sale, but of the far more serious offence of fraudulently manipulating it, whereas the truth may be that he is selling milk not adulterated in any way.

It would be much more satisfactory, alike to the farmer and consumer, if the wording of the Regulations was altered, and it were laid down that all sweet milk sold for human consumption should contain 3 per cent of fat. It would then clearly be the farmer's duty to keep cows that would yield a milk of the required richness, and to feed them in such a manner that the standard would always be maintained.

But there is another side to this question, because it is no uncommon thing to find milk, sold in the ordinary way, which contains as much as 5 per cent of milk fat. Now, is it fair to the farmer whose cows produce such rich milk that he should get no more for it than his neighbour whose cows yield a milk containing 3 per cent of fat and no more? Such considerations would seem to indicate that milk might, with advantage to all concerned, be sold not merely by quantity but also by quality. Milk sent to creameries is paid for according to the amount of fat which it contains—why should milk not be sold for ordinary consumption in a like manner?

Method of Retailing Milk.—The habit of retailing milk by price instead of measure, which is in vogue in many parts of the country, is objectionable. It would be a decided advance if fixed standard measures were universally adopted in the milk trade, just as they are in other branches of retail traffic, so that the consumer might know the exact quantity he was getting irrespective of the price he had to pay for it.

Colostrum (popularly known as "beastings") is the name given to the milk of newly-calved cows. It is an opaque, yellow liquid, of pungent taste, sometimes containing blood, which shows its presence by a reddish colour. It may give rise to indigestion, gripings, and diarrhœa, especially in infants, and a rule should therefore be made that at least four days be allowed to elapse after the birth of the calf before the milk is employed for human consumption.

It is unfortunate that there is no legislation on this point, as colostrum is too frequently sold to the public.

Manipulation of Milk.—An immense deal of manipulation of milk goes on, and this is carried out, not so much by the farmer, who has generally little aptitude in such matters, but by the middleman, who frequently realizes large profits as a result of his manipulative skill. Thus milk which contains more than the 3 per cent of fat is "toned" down with skimmed or separated milk until it reaches the required standard, and, as the latter material can be bought at a very low price, it is not difficult to understand how large profits

may be made. If this "toning" down process be done with care, its detection by chemical analysis is wellnigh impossible.

Manner of taking Samples of Milk under the Sale of Food and Drugs Acts.—The inspector charged with the duty of taking samples of milk under the Sale of Food and Drugs Acts must go about it in the manner prescribed by these Acts, otherwise, even though adulteration be proved by analysis, the prosecution will fall to the ground. With this end in view Sec. 6 of the 1875 Act should be carefully studied; further, if it is desired to take a sample in the course of delivery, Secs. 3 and 4 of the Amending Act of 1879 and Sec. 14 of the Act of 1899 will require attention. It should be borne in mind, in the latter case, that the milk is asked for and not purchased (any article other than milk can only be sampled in the course of delivery at the request of or with the consent of the consignee or purchaser). The following is a brief outline of the manner of taking samples in the ordinary way (not in course of delivery).

Three bottles are required for each sample that is to be be taken. Eight-ounce bottles, with tight-fitting corks and with labels attached, are suitable for the purpose. Besides the inspector, an assistant is necessary to act as witness and to assist the inspector in making the purchase. It is usual for the assistant to enter the milkshop, jug in hand, and ask for two pennyworth of "sweet" milk. The word "sweet" must not be omitted, otherwise the prosecution will fail. The inspector must meanwhile be within hearing, and as soon as the milk is measured out he comes forward, pays for it, and announces that "this sweet milk has been bought for the purpose of analysis by the public analyst". This announcement must be made (Sec. 14 of the 1875 Act). The seller may now say that the milk was not sold for sweet milk, but this will not help him. Sweet milk was asked for, and if he could not supply it he should have said so.

The milk must now be divided into three equal parts and

put into the bottles provided for the purpose, the corks being securely fixed in position by twine tied round the necks of the bottles, and sealed with sealing-wax bearing the official stamp of the Public Health Department. Upon the label attached to each bottle the following particulars are written in ink: (1) The number of the sample (the seller's name is not put upon the label; (2) description of article, *i.e.* sweet milk; (3) date; (4) signature of inspector. The name of the seller and the occupier of the milkshop, along with the address, should be written opposite the number of the sample in the inspector's notebook.

One of the bottles is then offered to the vendor, another is sent to the Public Analyst either by registered post or else by messenger—the latter may be required to appear in court and testify that he delivered it into the hands of the Public Analyst—and the third is retained under lock and key in a cool place, because it may be required for analysis, and must always be produced in court if prosecution should take place.

For manner of taking samples of other articles see p. 163.

The "Appeal to the Cow".—In connection with milk prosecutions what is known as "the appeal to the cow" is sometimes resorted to. A farmer, desirous of proving that the milk sold by him was not adulterated, may offer to milk the cow before witnesses, and submit a sample of the milk so obtained for analysis. If this milk be likewise below the standard, then it may be assumed that the poor quality is due to the cow, and not to the milk having been tampered with.

It is the duty of the inspector, when superintending such a test, to satisfy himself that the cow has been milked "dry", otherwise, on account of the fact that the strippings are richest in fat, the milk may fall below the standard, and the farmer may improperly get credit for selling unadulterated milk.

Vendors' Excuses for the Poor Quality of Milk.—In connection with milk prosecutions the excuse is frequently made

that the sample obtained by the inspector was taken from the bottom of the receptacle containing it, after the richer portions of the milk had risen to the surface and had been sold to earlier customers; and hence, though the quality of the milk as a whole was up to the standard, the sample may have been deficient in fat. This is no valid excuse, since it is the duty of the vendor to see that the milk is thoroughly stirred up and mixed through as each customer is served.

Again, where samples are taken from a barrel on a milk cart, and found below 3 per cent of milk fat, the injustice of taking a sample from the bottom of the barrel is generally complained of, as it is alleged that the cream will have risen to the top. In order to prove the accuracy of such statements Mr. Dunbar tried the experiment of drawing samples at various intervals from a tap at the bottom of an ordinary milk barrel containing 8 gal. of milk conveyed on a cart. This experiment was conducted with very great care and attention to all details likely to have a bearing on the result. The conclusion come to by Mr. Dunbar is that "this experiment proves conclusively that there is no foundation in fact for the allegation that milk fat rises to the surface of the milk in a barrel conveyed on a cart".

The truth seems to be that the jolting of the cart as it is driven along keeps the milk thoroughly mixed through, and prevents the cream rising to the surface.

Chemical preservatives are frequently added to milk in order to check the growth of micro-organisms, and thus make it keep for a longer time than it otherwise would do. The most commonly used are boric acid and its sodium salt, borax, salicylic acid, and formaldehyde.

The addition of such preservatives is undesirable, because they retard the growth of bacteria without destroying them, and thus enable the vendor to sell stale milk instead of fresh. It is, indeed, merely a cloak for laziness or uncleanliness on the part of the cowkeeper or dairyman.

Richmond, analyist to the Aylesbury Dairy Company, in his admirable book on dairy chemistry, says: "The author's

experience has shown that in London the use of preservatives in milk is entirely unnecessary. No difficulty has been found, even in summer, in delivering milk to customers in a fresh condition."

We may take it, therefore, that the use of preservatives in milk is altogether unnecessary when milk is treated in a proper manner.

Perhaps the chief danger attending the addition of preservatives lies in the fact that, with each change of hands through which the milk goes, from the farmer to the retail shopman, a fresh quantity of the preservative may be added. Again, we have no control over the amount of the preservative that any particular individual may add, and the successive handlers may conjointly add a very large quantity indeed.

When it is remembered that milk frequently forms the main or sole source of nutriment of infants and invalids, it will be appreciated how undesirable it is that substances, which, even in small quantities, are by no means innocent in their action on the human system, should be added to milk.

The Departmental Committee appointed by the Board of Agriculture, 1901, recommended that—

(*a*) The use of any colouring matter or preservative in milk be made an offence under the Sale of Food and Drugs Act.

(*b*) That boric-acid preservatives be only allowed in cream, the amount not to exceed 5 per cent.

In Mr. John Burns's report on the work of the Local Government Board (1907–8), he says: "Our view is that no preservative whatever should be added to milk".

PART II

Milk in Relation to Disease

CHAPTER I

Milk from Tuberculous Cows

Can Bovine Tuberculosis be Transmitted to Man?—Tuberculous Milk as a Cause of Phthisis—Other Forms of Tuberculosis—The Number of Tubercle Bacilli in Milk in Relation to the Probability of Infection—Must the Udder be affected with Tuberculosis before the Milk becomes Infectious?—The Diagnosis of Tuberculosis in Living Animals—Tuberculin Test—Ophthalmic use of Tuberculin—Veterinary Inspection of Cows' Udders—Steps taken by Sanitary Authorities to reduce the Prevalence of Tuberculous Milk—How has Tuberculosis obtained such a widespread hold among our Cattle?—Insanitary Conditions of Housing—Cows kept indoors for months at a time—Inbreeding—Excessive Milking—Manner in which the Prevalence of Tuberculosis among Cattle may be Lessened—Method adopted by Bang of Copenhagen—Vaccinating Cattle against Tuberculosis—What has been done in certain Towns to Lessen the Percentage of Tuberculous Milk.

Can Bovine Tuberculosis be Transmitted to Man?—Since Koch, at the London Congress on Tuberculosis in 1901, expressed the opinion that bovine tuberculosis was scarcely, if at all, transmissible to man, there has been much discussion on this subject.

The British Royal Commission appointed to enquire into the relations of human and animal tuberculosis state in their second interim report, issued in January, 1907, that: "There can be no doubt but that in a certain number of cases the tuberculosis occurring in the human subject, especially in children, is the direct result of the introduction into the human body of the bacillus of bovine tuberculosis; and there also can be no doubt that in the majority at least of these cases the bacillus is introduced through cows' milk. Cows' milk containing bovine tubercle bacilli is clearly a cause of tuberculosis and of fatal tuberculosis in man.

"A very considerable amount of disease and loss of life,

especially among the young, must be attributed to the consumption of cows' milk containing tubercle bacilli. The presence of tubercle bacilli in cows' milk can be detected, though with some difficulty, if the proper means be adopted, and such milk ought never to be used as food. There is far less difficulty in recognizing clinically that a cow is distinctly suffering from tuberculosis, in which case she may be yielding tuberculous milk. The milk coming from such a cow ought not to form part of human food, and indeed ought not to be used as food at all."

"Our results clearly point to the necessity of measures more stringent than those at present enforced being taken to prevent the sale or consumption of such milk."

There can therefore no longer be any doubt but that the milk of tuberculous cattle is undoubtedly a source of danger to those drinking it. There is still, however, much difference of opinion as to the extent of such danger.

Tuberculous Milk as a Cause of Phthisis.—It was formerly assumed that phthisis (tuberculosis of the lungs) was always caused by inhaling the specific organism into the lungs. Of late years the belief has been steadily gaining ground that pulmonary tubercle in man may, at least in many cases, be due to bacilli ingested along with milk or other food.

It may seem strange that the stomach or intestines should form, as it were, an entrance to the lungs; yet the work of Behring, Calmette, Guerin, and others points very strongly to the fact that bacilli, entering the body through the intestines, may find their way to the lungs and produce mischief there. Many authorities, indeed, claim that most cases of pulmonary tuberculosis are produced by tubercle bacilli gaining entrance to the body, not through the lungs, but through the intestines, and much can be said in favour of this view.

Behring believes that most pulmonary tuberculosis is contracted in childhood from drinking tuberculous milk, though the disease may remain dormant for many years, manifesting itself in later life as a result of the patient becoming run down in health, or from some other cause.

Other Forms of Tuberculosis.—Tuberculosis attacks many other parts of the human body besides the lungs, and appears in many other forms besides phthisis. Thus tubercular disease of the bones and joints is very common; the intestines, mesenteric glands, and brain membranes are likewise frequently affected. There is every reason to believe that tuberculous milk may be as potent a factor in the causation of the latter forms of the disease as in phthisis, a point that is sometimes overlooked by the sanitarian.

One of the best indications of the amount of tuberculosis which is caused by food—especially milk—is the very favourable results which have been recently obtained in the curative treatment of the disease by tuberculin made from tubercle bacilli of bovine origin. Many cases, on which tuberculin made from human tubercle bacilli seemed to have little effect, show rapid improvement when bovine tuberculin is substituted, pointing very clearly to the origin of the disease.

Behaviour of the Tubercle Bacillus in Milk.—It is probable that the tubercle bacillus does not, under ordinary circumstances, multiply in milk. This organism will not multiply at all unless the temperature approach that of the body, and even then only when grown on a specially prepared nutrient medium. Tubercle bacilli, therefore, which pass from the cow into the milk, may remain alive therein for a very considerable time, but they do not become more numerous.

The Number of Tubercle Bacilli in Milk in Relation to the Probability of Infection.—It is frequently stated that tubercle bacilli are incapable of producing the disease in man unless ingested in large numbers. Many authorities believe, therefore, seeing that the bacilli do not multiply in milk, and as infected milk is usually diluted with uninfected milk, that the germs will generally be reduced in numbers to such an extent that the danger of contracting tubercle from milk is very slight. It is probable that quite the contrary is the case, and that the mixing of milk containing pathogenic bacteria with wholesome milk renders the whole mixture infective. That this is the case was well brought out in Minnesota and

other places where pigs fed with a mixture consisting of milk containing living tubercle bacilli, and wholesome skim milk, became infected with tuberculosis; the dilution did not prevent them from contracting the disease, which continued to spread until a law was passed prohibiting the feeding of swine with factory skim milk containing any living tubercle bacilli, no matter how few in number.

In order to give some idea of the frequency with which the tubercle bacillus may be found in milk—as it is actually placed on the market—the following examples may be given.

Kanthack and Sladen found the tubercle bacillus present in the milk of nine out of sixteen dairies examined at Cambridge. In Islington 14·4 per cent of the samples were found to contain the tubercle bacillus. In Hackney 22 per cent of the milks examined contained the bacillus.

The London County Council found 11·6 per cent of the samples tuberculous.

Delépine, speaking of the results obtained in Manchester, says that 21·2 per cent of the farms and 28·3 per cent of all the cows supplying milk to Manchester have at one time or another been tuberculous. Speaking generally, the same authority says: "One can say, without exaggeration, that there are few herds of more then 10 cows that do not include one or more tuberculous cows."

Unquestionably the human body has certain powers of resistance against the tubercle bacillus, otherwise it is difficult, in view of the above percentages of infected milk, to see how anyone could escape; but in the case of infants or invalids, whose powers of resistance are feeble or impaired, the presence of the organisms at all must always be a source of danger.

It is striking that of the 60,000 persons who die annually from tuberculosis in this country, 11,000 should be children under five years of age, *i.e.* 11,000 deaths in that section of the community which depends most upon milk for its nourishment.

The further this question is studied the more firmly convinced does one become that milk is one of the great factors responsible for the spread of tubercular disease among human beings; and when it is remembered how many fall victims to its ravages, and the many and varied forms in which it may attack the human frame, surely the urgent necessity of doing everything in our power to check its prevalence and spread must become apparent.

If the public could be supplied with milk entirely free from tubercle bacilli, an enormous stride would have been taken in the direction of ridding them of a disease which has been aptly described as the "white man's plague".

Must the Udder of the Cow be affected with Tuberculosis before the Milk becomes Infectious?—The next point that concerns us is, is it only the milk of cows suffering from a tubercular condition of the udder that may contain tubercle bacilli, or may the milk of cows, without tubercle of the udder, but with tubercular lesions in other parts of the body, also contain the bacillus?

Many British authorities hold that the milk of a cow only contains tubercle bacilli when the udder is affected. Mohler's investigations, however, point in an entirely opposite direction. He found that out of 56 cows which reacted to the tuberculin test, but without evident tuberculosis of the udder, 12 or 21·4 per cent, at one time or other during the experiment, gave milk which contained virulent tubercle bacilli.

Rabinowitch and Kempner also obtained positive results by inoculating guinea pigs with the milk of 10 cows that reacted to tuberculin. Of these 10 animals, only 1 showed clinical evidence of involvement of the udder, and only 1 other showed any sign of it on microscopic examination.

Delépine, who has done much work on this subject, says: "In cases of tuberculosis without clear affection of the udder there may also be occasional infection of the milk. There is a difference of opinion as to whether the appearance of tubercle bacilli in the milk is evidence of the onset of mammary lesions, or may occasionally be entirely unconnected with

mastitis. There is however no difference of opinion as regards the danger of infection of the milk in all cases of advanced tuberculosis; in such cases the udder is either diseased, or liable to become diseased at any moment. . . . Although it is difficult to deny the possible danger of other sources of infection it is clear that tuberculous infection of the milk is in a very high proportion of the cases due to tuberculosis of the udder. It is also obvious that all cows in a state of advanced tuberculosis are potentially dangerous on account of their liability to tuberculosis of the udder and of the infectiousness of their dejecta. Under the present conditions the proportion of tuberculous animals among cattle of more than four years is considerable."

It is interesting in this connection to note the experience of Dr. Sims Woodhead. In his investigations for the Royal Commission, in 1890, he became impressed by the fact that the spread of tubercle in the udder goes on with alarming rapidity, and noticed that on several occasions the disease had become distinctly developed between fortnightly inspections carried out along with a veterinary surgeon.

It is probable that the bulk of tuberculous milk is derived from cows with tuberculosis of the udder. This fact must, however, not give rise to any false sense of security. Because if a cow be tubercular at all, more especially if it be suffering from advanced tuberculosis, one never knows the moment that the udder may become involved. Further, in the early stages of the disease in the udder it is difficult or impossible for even an experienced veterinary surgeon to decide whether the organ is affected or not. Thus it is only after the milk has become infectious, and harm has probably been done, that the disease in the udder can be detected.

In carrying out experiments on this very important subject the utmost care must be taken to prevent the milk drawn from tubercular cows, the udders of which appear normal, from becoming contaminated during milking with tubercle bacilli from sources external to the cow. Thus if the lungs or

intestinal tract be affected, the coat of the cow and the byre in which she lives will almost certainly harbour the tubercle bacillus, derived from her nasal secretions, or dung, and it requires the utmost vigilance on the part of the investigators, as the author found from certain experiments conducted on the Continent, to prevent the entrance of the bacilli into the milk during the milking process.

The experiments referred to clearly proved this fact, that milk derived from a byre in which tubercular cows are lodged may become contaminated with the tubercle bacillus from the outside during milking carried out in the ordinary manner. The tubercle bacilli are in such cases derived from the dung and nasal secretions of infected animals. It appears, therefore, that even if it were the case that the udder of the cow requires to be diseased before it is capable of secreting tubercular milk, the very fact that cows affected with tuberculosis are in the byre at all would in itself constitute an element of danger. Thus it becomes evident that the danger of spreading tubercle by means of milk will never be got over until the tubercular cow is entirely eliminated from our dairy herds.

In considering how this may be accomplished, the first matter of importance is to know how the disease may be recognized in the living animal.

How may Tuberculosis be Recognized in the Living Animal?—Cattle which live chiefly in the open air, such as Highland and Irish cattle, and those that roam the prairies of America, are generally healthy and comparatively free from tuberculosis, whereas those which are used for dairy purposes, and are housed for considerable portions of the year in dark, warm, and ill-ventilated byres, and which have been "forced" for the production of milk, are much more liable to the disease. The Ayrshire, Shorthorn, Jersey, and Guernsey breeds are those in which tuberculosis is said to be most prevalent. It should also be borne in mind that old cows are much more liable to tuberculosis (especially of the udder) than younger ones. It is very difficult to diagnose tuberculosis in the living

animal, and this was for many years the great stumbling-block in dealing with the disease.

Tuberculin Test.—Luckily, however, the tuberculin test, when properly applied, gives very accurate results, and it is on it that we depend chiefly for the diagnosis of tubercular disease among dairy cattle.

Tuberculin is a fluid containing the toxin (or poisonous substance) produced by the tubercle bacillus. Nocord describes its preparation as follows: "A culture on glycerin bouillon is incubated for six weeks at a temperature of 37° C. This is next sterilized in an autoclave at 110° C. Next it is concentrated in vacuo in the presence of sulphuric acid, or in a water-bath, until the culture is reduced in bulk to one-tenth of its original size. It is then filtered through germproof filters and stored away from heat and light in hermetically closed vessels."

The rationale of the test is this, that if an appropriate dose of tuberculin be injected into an animal suffering from tuberculosis a well-marked reaction in the form of a rise of temperature takes place, whereas if injected into a sound animal no reaction occurs.

Precautions to be Observed.—Cattle should never be tested by tuberculin after having been driven long distances, or after a journey by boat or rail, but should have been at least a week in their homes under ordinary conditions before the result of the test can be regarded as accurate. The test should only be carried out while the animals are in every way under normal conditions, and they should be kept tied up in a byre for at least twenty-four hours before it is performed. Very little causes the temperature of some cows to rise; if they are brought in from the fields, and not allowed out as usual, the excitement caused thereby may be sufficient to produce a slight increase in their temperature. It is very important that animals to be tested by tuberculin should have a normal temperature prior to the commencement of the test. It is, indeed, advisable to take the rectal temperature morning and

evening for about three days before applying the test, as, unless the temperature is about normal, the results obtained by the tuberculin cannot be relied on.

Manner of Taking the Temperature.—The temperature of a cow is taken by inserting the thermometer well into the bowel, and, as this not infrequently gives rise to defecation, it is advisable to tie the instrument loosely to the tail of the animal. The rectal temperature of a normal cow varies from about 100·5° F. to 102·5° F.

Directions for using Tuberculin.—Great care and attention to cleanliness should be observed in performing the test. The operator's hands should be thoroughly washed, and steeped in some antiseptic solution. Before injecting the tuberculin, the hair of the animal to be tested should be clipped close to the skin at the place where the injection is to be made, and the skin itself well washed and rubbed with a piece of gauze or other material soaked in a solution of corrosive sublimate—1 in 500—or other antiseptic solution.

The following directions for the use of tuberculin are issued from the Research Laboratory of the Royal Veterinary College, London, by Sir John MacFadyean:—

"1. While under the tuberculin test, cattle ought to be kept in the house, fed on their usual food, and protected from draughts.

"2. The dose of tuberculin for a medium-sized cow is 3 c.c., or 50 minims, and it may be varied a little above or below that, according to the size of the animal.

"3. It ought to be injected under the skin with a clean hypodermic syringe. The most convenient points are in front of the shoulder, or on the chest wall behind the point of the elbow. The best form of syringe is one with an asbestos piston, as the whole instrument may be sterilized by boiling it in water for five minutes before use.

"4. The tuberculin must be injected into the subcutaneous connective tissue, and care must be taken that the whole dose is introduced.

"5. The temperature must be taken at the time of injection, and at the ninth, twelfth, fifteenth, and eighteenth hours afterwards. When there is any reason to suppose that the animal may have been already tested with tuberculin during the preceding two or three weeks, it is advisable to take the temperature at the third and sixth hours, as well as at the times just mentioned.

"6. Animals in which the temperature, during the eighteen hours following the injection, rises gradually to 104° F., or more, may be classed as tuberculous, and those in which it remains under 103° F. as not tuberculous. When the maximum temperature attained is under 104° F., but over 103° F., the case must be considered doubtful, and the animal may be retested after a month.

"7. The test is not reliable in the case of animals in the last stage of the disease, or in those in which the temperature is over 103° F. before injection.

"8. The tuberculin should be kept in a cool place, and protected from light. Should it become turbid or cloudy, it must not be used.

"9. The tuberculin test does not render the milk in any degree injurious."

The Use of Mallein as a Means of Diagnosing Glanders.—Mallein is a substance prepared from the glanders bacillus in very much the same way as tuberculin is prepared from the tubercle bacillus, and its use as a diagnostic agent is very similar. The temperature of the animal should be observed for some hours beforehand, and, after subcutaneous injection of a suitable dose, it is taken at definite intervals—at the sixth, tenth, fourteenth, and eighteenth hours afterwards, and on the next day (M'Fadyean). Attention must be paid not merely to the temperature, but also to the local reaction. In a glandered animal a painful local swelling (which may reach a diameter of 5 in. or more) appears at the site of inoculation—it does not attain its maximum size until twenty-four hours after the inoculation. The temperature rises 1·5°–2° C., or more, the maximum generally occurring in from eight to sixteen hours. If the temperature does not rise as much as 1·5° the reaction is considered doubtful. In an animal free from glanders the rise of temperature does not usually exceed 1°, and the local swelling reaches a diameter of not more than 3 in., and has much diminished at the end of twenty-four hours.

The Ophthalmic Use of Tuberculin.—It has recently been discovered by Calmette and others that if a glycerin-free solution of tuberculin be placed in the eye of a tuberculous animal, a characteristic reddening of the lining membrane of the eyelids is produced, together with watering of the eye and the formation of a fibrinous exudate—a reaction which does not follow the use of the solution in a non-tuberculous animal. Symptoms of reaction are noticeable in from three to eight hours, increasing to a maximum in from six to fourteen hours, and disappearing usually in from twenty-four to thirty-six hours.

We understand that this test is being used in the Argentine, but it is too soon yet to say much with regard to its efficiency.

Veterinary Inspection of Cows' Udders.—As already said, it is difficult or impossible, by a mere external examination of a cow's udder, to determine whether that organ is affected by tuberculosis. This fact is well illustrated by the results obtained in a certain district in which the udders of all milk cows are periodically inspected by veterinarians. When these same cows are, shortly after the inspection, sent to the abattoir, where a thorough system of meat inspection prevails, it is no uncommon thing to find well-marked conditions of the udder which veterinary inspection during life has failed to detect.

"Tuberculosis of the udder can be detected with great accuracy by a combination of veterinary inspection of the cows and of bacteriological examination of the milk obtained from udders showing signs of disease, more especially enlargement and induration. It is unfortunately impossible for the most experienced veterinary surgeon to distinguish, by inspection and palpation, tuberculous mastitis from all other forms of mastitis. It is also practically impossible for the veterinary surgeon, unaided, to discover by ordinary inspection early tuberculous lesions of the udder."—*Delépine.* It is obvious, therefore, that veterinary inspection must be combined with bacteriological examination of the milk, if it is to be effective.

Manner of Conducting Inspection.—The udder of a cow should always be inspected after milking, when it is empty, as abnormal changes are easier of detection when the organ is in that condition. On palpation (grasping with the hand) a normal udder, when empty, feels uniformly soft, and the skin can be moved freely over its surface. When tuberculous, one or more quarters generally become enlarged and some hardness and irregularity are usually present. The supramammary lymphatic glands, which lie behind the udder on either side, close to the inner aspect of the hind leg, are difficult to locate when normal, but when tuberculous they become enlarged and firmer in consistence so that they may be readily felt through the skin. In tuberculosis of the udder they are nearly always affected also. (See page 36.)

The milk from a tuberculous udder is sometimes altered in charactor. Thus it often becomes diminished in quantity, and thin, watery, and serous in consistence. It has sometimes a slight yellow tint, and may contain flocculi and flakes of a larger size than normal. Very little reliance can however be placed on the altered character of the milk, as a cow with advanced tuberculosis of the udder may give a large quantity of creamy looking milk. When it is difficult to decide whether an udder is tuberculous or not, samples of milk should be taken and submitted to bacteriological examination.

Steps taken by Sanitary Authorities to reduce the Prevalence of Tuberculous Milk.—The sanitary authorities of many of our towns and cities have, in recent years, obtained special powers from Parliament to enable them to deal with tuberculous milk sent in from the surrounding country districts. So far authority has not been given them to test farmers' cows with tuberculin, and their method of procedure has therefore been somewhat as follows: Samples are taken by inspectors from churns of milk consigned from the country to the railway stations, and these are submitted to bacteriological examination. In the case of samples containing tubercle bacilli, a clinical examination of the cows at the dairy farm from which the milk was derived is made by a veterinary inspector appointed for the purpose. Excellent results have in many cases been derived from such a method of procedure, but nothing further need be said here with regard to it, as the subject is discussed fully at the end of this section.

How has Tuberculosis got such a Widespread Hold among our Cattle?—Having seen how tuberculosis may be recognized in cattle, the next question that we have to consider is—how has this disease got such a widespread hold among them?

We have already seen that animals that live out-of-doors all the year round show a well-marked freedom from tuberculosis.

The ideal condition, were it possible, would be for dairy

cows to remain summer and winter in the open air; and, were this carried out, tuberculosis, which is at present so prevalent, would be reduced to a minimum. Animals living habitually in the open air, however, grow more slowly, and seldom attain to the same degree of development as those which are housed during the colder part of the year; they eat proportionately more food, and, in the case of cows, are supposed to yield less milk. It would therefore not be profitable for the farmer to keep his cattle out-of-doors during the wintertime. The business instincts of the dairyman lead him in an altogether different direction. He looks upon the cow as a machine out of which he must get the greatest yield of milk from the smallest quantity of food.

As already said, the belief exists among dairymen, whether rightly or wrongly, that cows in a warm atmosphere produce more milk than in a colder one. Such men are therefore not, as a rule, friendly disposed to ventilation—which would diminish the temperature—or to the cows living in the open air in the wintertime.

Again, as few byres are artificially warmed, the heat for warming the byre is derived from the bodies of the animals themselves, and it is a common practice to prevent its escaping by restricting the ventilation as much as possible. Thus it is no uncommon thing to find even the few ventilators—quite inadequate for the purpose—which is all that many of our byres possess, stuffed with straw in the wintertime, in order to increase the warmth of the interior.

Insanitary Conditions of Housing.—Far too many byres throughout the country at the present time, however good they may be for "forcing milk", are certainly not sanitary even in the widest use of the term. Thus they are often dark, ill-ventilated places, with few or no windows, and no adequate system of ventilation. Their walls are rough and uneven; their floors, laid with no proper fall, for the purpose of carrying off surface drainage, are in many cases pitched with large cobble stones, or laid with uneven or broken flagstones, the spaces between which

afford lodgment for dung or other filth which cannot be swept out or washed away. The middens are not infrequently situated within a few feet of the byre door, and, perhaps worst of all, it is no uncommon thing to find the byre in direct communication with the dwelling house of the farm, and I have even known of a pig sty under the same roof as the byre, only separated from it by a door, which was seldom closed.

Such byres, dark, warm, and damp from the breaths and exhalations of the cows, present just the very conditions necessary for the growth and multiplication of the tubercle bacillus; indeed, were they designed as chambers for the cultivation of that organism, they could scarcely be more suitable for the purpose. Very often, too, the cleansing of the byre is carried out in a very perfunctory manner, and the cows' beds are not sufficiently often changed, with the result that the hind quarters, and even the very udders, of the animals become besmeared with dung, while the moist, damp atmosphere, acting upon the imperfectly cleaned floors, gives rise to an effluvium so heavy and offensive as to render the air of the byre overpowering and suffocating in character.

Cows Kept Indoors for Months at a Time.—Added to all this, it must be borne in mind that cows, especially in towns, are often kept chained up for months at a time in the byre, never being permitted to go out for a breath of fresh air, their only exercise being that involved in getting up and lying down in the stall in which they are imprisoned.

The dairyman, however, having converted the cow into little more than a hothouse plant, is not content to let the matter rest there. He has for many years been engaged in trying to produce cows with the largest possible udders, and retains only those of the heaviest milking strain. In this object he has been aided and abetted by the Agricultural Shows, which award prizes for dairy cows with large vessels and great milk-producing properties. To produce such animals in-breeding has been much resorted to, with the result that their disease-resisting power has been reduced.

Again, by constant and prolonged milking, the normal period of lactation is drawn out, so that many cows are scarcely dry before they have another calf, and are once more in full milk. This constant milking and calf-production must throw a very great strain upon the animal's system.

Is it any wonder, therefore, when we consider the wretched manner in which so many milch cows are housed, the in-breeding to which they have been subjected, the strain thrown on their systems by constant milk-depletion, and the many other causes at work to undermine their constitutions, that they are so often found to be tuberculous? Is it not, rather, a cause for surprise that, all things considered, they are even as healthy as they are?

Manner in which the Prevalence of Tuberculosis among Cattle may be Lessened.—Without considering whether our dairy cattle should be subjected to a national system of inspection, and, if so, in what manner the inspection should be carried out, or touching on the vexed question as to whether farmers should receive compensation for animals that are found diseased and therefore condemned, because such problems come more within the province of the legislator than the sanitarian, this much, at least, is certain, that until the farmer is induced, in some way or other, to regard the health of his cows as a matter of more importance than the amount of milk that they produce, the public safety from tuberculous milk will not be secured.

Education of the Public as to the Danger of Tubercular Milk.—Apart from legislation, however, much may be done by educating the public as to the risks incurred by the ingestion of tubercular milk. Once they awaken to the importance of this question they will no longer be content to drink milk in the old way, but will require the farmer to produce some guarantee that his cows are in a healthy condition, and the farmer who wishes to retain his customers will then be compelled to give the matter his very serious attention.

Methods which the Farmer may Employ for Reducing the Prevalence of the Disease among his Cattle.—How, then,

should a farmer set about the task of eliminating tuberculosis from among his dairy cattle?

On the Continent much has already been done by a systematic application of the tuberculin test, followed by separation and isolation of the diseased animals.

Professor Bang, of Copenhagen, uses the tuberculin test very extensively as a means of eliminating the tubercular animals from a herd. He tests the whole of the cows, and separates those that react, from the others. This separation must be absolute, the affected animals being put into different sheds, as far removed from those in which the sound animals are housed as possible, and being attended by different attendants. Meanwhile the byre devoted to the healthy cows undergoes a very thorough disinfection. The cows that react are now fattened for the butcher, with the exception of those which seem but slightly affected by the disease, which are allowed to have one more calf. These calves, which are almost invariably born healthy, are immediately removed from their mothers, and are taken over to the premises where the healthy cows live, where they are fed either on pasteurized milk or that derived from healthy cows. Such calves, as well as all the cows which failed to react to the first injection of tuberculin, are tested once every six months, and any that react are removed and fattened, as were their predecessors.

All newly purchased cows are tested and sent to one or other establishment, according as they react or not, and are again tested six months later, if the first result was negative.

It is claimed that in the course of about two years, if this method is conscientiously carried out, the herd will be found free from the disease, and will remain free, provided that all newly purchased animals are kept apart until they have been twice tested, viz. on arrival and at the expiration of three to six months.

In many of the American States attempts are being made on a large scale to eradicate tuberculosis from cattle by means of the tuberculin test, followed by slaughter or separation of the affected animals and disinfection of the cowsheds. Much

useful information on this subject might be obtained by studying American methods.

If young cows were kept for milking purposes, and the older ones were, on account of their greater liability to the disease, fattened for the butcher, there is no doubt that a reduction in the amount of tuberculous milk on the market would be effected.

We personally do not believe that, in the present state of our knowledge, any method will be successful in entirely eliminating bovine tuberculosis on a very large scale. That the disease could be enormously lessened and kept under control is beyond question, but until we know more of the natural history of the causative bacillus the extinction of tuberculosis among cattle will ever be difficult or impossible.

Vaccinating Cattle against Tuberculosis.[1]—In recent years the State Live Stock Board of Pennsylvania have been experimenting with vaccination as a means of preventing tuberculosis in cattle, a herd of 100 animals having been set aside for the purpose. The vaccine used consists of a slightly virulent virus isolated from the sputum of a consumptive girl. Three successive doses of living bacilli are injected intravenously at intervals of from six to eight weeks. Dr. Pearson, in September, 1906, summarized his results as follows:—

"Not one animal that has been vaccinated in accordance with the method that we are now using . . . has become tuberculous from natural exposure to the disease, nor has any animal been injured by vaccination. With such evidence, covering four years and a large number of cattle, we have felt that we are amply justified in recommending vaccination and in applying it in practice."

Without more extended investigation one would be slow to believe in the efficacy of such vaccination in solving the tuberculosis problem in cattle.

The housing of cows, as we have seen, has a very important bearing on the tuberculosis question, and, whatever plan be adopted to get rid of the disease, it is absolutely essential that improvement should take place in the construction and ventilation of byres, otherwise all other preventive measures will be of no avail. Cows may unquestionably affect one

[1] See Dr. Eastwood's *Report to the L.G.B. on American Methods for the Control and Improvement of the Milk Supply.*

another; thus, when a byre is being tested with tuberculin for the first time, it is often noticed that the diseased animals occur in groups in contact with each other. Sufficient air space and ventilation are requisite for the wellbeing, not only of men, but also of animals.

Further, it is not merely the dairy byres, where milking cows are housed, that require attention. The premises where calves and young cattle are kept should also be properly constructed, otherwise these animals may contract the disease while young, and thus the attempt to eradicate tuberculosis will be frustrated. At many farms the milking cows are kept in good clean byres, while the calves, heifers, and young bulls are housed in dark, ill-ventilated, and dirty sheds, it being apparently thought that anything is good enough for them. As these young animals will, as they grow up, take their place as milking cows and breeding bulls, it is easy to see that such a state of matters is very objectionable.

WHAT HAS BEEN DONE IN CERTAIN TOWNS TO LESSEN THE PREVALENCE OF TUBERCULOUS MILK

The Manchester Method

The Sanitary Committee of Manchester in 1898 applied to Parliament for special powers to enable it to deal with the city's milk supply in a more satisfactory manner. As a result the Manchester Milk Clauses were obtained. See p. 139.

The report of the medical officer of the Local Government Board for 1908–9 contains an admirable report by Dr. Delépine on "Investigations in the Public Health Laboratory of the University of Manchester upon the Prevalence and Sources of Tubercle Bacilli in Cows' Milk". Embodied in this report is much useful information on the working of the Manchester Milk Clauses and the results obtained therefrom. The following quotations are derived from that source:—

"The collection of samples and the inspection of farms are conducted as follows: Samples of milk are obtained at the railway stations, or elsewhere within the city, by the Food and Drugs Inspectors. These samples are submitted to bacteriological examination. All samples found to cause tuberculosis are followed to their source at the farm by the medical officer of health (or his representative) and the veterinary surgeon."

"The veterinary surgeon examines all the milk cows on the farm, and takes separate samples of milk from cows having diseased or suspicious udders. These samples are examined bacteriologically, and when the milk of a cow is found to be tuberculous this is taken as proof that the udder is tuberculous. The farmer is required by the medical officer of health to isolate the affected cow, and at the same time is advised to have the animal slaughtered in the presence of the veterinary surgeon of the corporation. This advice is followed in a great number of cases, and opportunity is thus obtained not only to remove dangerous cows, but also to control the value of the bacteriological tests."

"It sometimes happens that the farmer disposes of one or more cows in the interval between the taking of samples and the completion of bacteriological examination. When this has taken place the veterinary surgeon attempts to trace the movements of any cow that has been removed from the farm. In this he is not always successful, owing to farmers frequently sending the suspicious cows to farms that are not under the administrative control of Manchester."

"When none of the samples obtained from udders showing evidence of some form of mastitis resembling tuberculous mastitis are found by bacteriological examination to be tuberculous, further mixed samples are taken either at the railway station or at the farm, and if the mixed milk remains infectious a further inspection of the farm is made. Unmixed samples are again taken and examined bacteriologically."

"At first the finding of udders yielding tuberculous milk was very slow, and in such cases I advised the dividing of the herd into groups of cows varying in number according to the size of the herd, a mixed sample being taken from each group. It was generally found that one of the groups yielded tuberculous milk, and it became then usually easier to find the infective cow or cows. This method has not been used of late in Manchester, but it has proved useful in other places. The final step consists in taking one or more samples of the mixed milk of the farm or shippon after the cow or cows with tuberculous udders have been isolated or eliminated. If these control samples are proved by bacteriological examination to be incapable of producing tuberculosis, the farm is considered, for practical purposes, to be free from sources of tuberculous infection of the milk *for the time being*."

Collection of Samples.—"The collection of samples entirely free from contamination is obviously essential to success."

"The inspector is provided with collecting apparatus which I have designed specially for the purpose. This apparatus consists of:—

"1. A glass bottle (8 to 10 oz. capacity) with an indiarubber stopper.

"2. A tinned copper milk scoop, with long handle, shaped like the milk measures used by milkmen.

"3. A copper metal case enclosing the scoop and bottle.

"The bottle, stopper, scoop, and copper case are cleaned and then

sterilized by steam under pressure at the laboratory. The inspector has strict injunctions not to open the case till the moment when he wants to use it, and to close it again immediately after taking a sample. The stopper must not be allowed to come in contact with any unsterilized object. It is usually deposited in the lid of the sterilized case while the bottle is being filled."

Collection of Mixed Milk.—"The Food and Drugs Inspector is instructed to include in a test sample some of the milk contained in the various milk cans coming from a shippon or farm. Care is taken to prevent the admission of any dirt when the milk cans are opened. The milk in each can is stirred up with the sterilized milk scoop, the inspector being careful not to allow his hand to come in contact with the milk. Obviously it would be difficult and inadvisable to stir thoroughly the whole of the milk contained in a milk can, and I have often found samples containing a marked excess of cream, indicating imperfect admixture. This, however, does not materially affect the results of the bacteriological examination."

Collection of Unmixed Milk.—"Samples of unmixed milk are collected by the veterinary surgeon at the time of his visit to the farm. The greatest care is taken to avoid the admixture with the milk of dirt from any source. Skilled veterinary inspectors milk the cow direct into the bottle; those with less practice may milk the cow into the sterilized scoop or case, and transfer the milk into the bottle. *None of the dairy vessels are used for this work, nor is the milkman allowed to take the sample or to handle the collecting apparatus.* In dealing with cases of early tuberculosis of the udder, in which lesions are so slight that they are difficult to recognize by palpation, it is usually preferable to collect the last milk, known as the 'strippings', in which cells and tubercle bacilli are usually more numerous than in the fore and middle milk. . . ." "By a kind of massage or manipulation of the udder it is often possible to obtain a few ounces of milk from an udder which appears to have been milked dry, and this milk is particularly rich in cells, and sometimes in morbid products which have been dislodged by the manipulation of the organ."

Forwarding the Samples to the Laboratory.—"When the inspector can arrange to deliver the sample at the laboratory within a few hours of the time of collection, no further precaution is needed than to keep the metal case securely closed until delivery. If the milk cannot reach the laboratory within four or five hours in the summer or ten hours in winter, the collector is directed to place the sample cases in a small portable refrigerator, in which cooling is obtained without the bottles being soiled by melted ice. The refrigerator which I supply for the purpose is of the same type as one which I have used since 1893 for the sending of samples of water to a distance."

Inspection of the Cow's Udder.—"The udder is situated between the two thighs, and its posterior narrower part is immediately

below the anus, vulva, and urethra; most of its parts are accessible to the tuft of the tail when the tail is swished. In addition to the usual four teats, sometimes there are two supernumerary teats. The skin over the udder is hairy except where it covers the teats. The organ is composed of two halves separated by a medium septum, each half having a teat on each of its two quarters. There is no distinct septum between the anterior and posterior quarters; nevertheless each quarter discharges its secretion through the corresponding teat, and one quarter may be diseased without the other quarter on the same side being affected."

"The consistency of the udder varies according as the organ is full of milk or empty. When the organ is distended with milk it feels uniformly tense. When empty it feels uniformly soft, and the skin can be pushed deeply between the two halves, or between the wall of the abdomen and the gland. When the udder is diseased certain of its parts may be enlarged or indurated, and these changes can usually be recognized by inspection and palpation *when the udder is empty*. There is one lymphatic gland at the posterior end of each half of the udder close to its attachment to the abdominal wall and to the inner aspect of the thigh. These glands are soft and difficult to recognize by palpation when they are normal, but when diseased they often reach a large size and may then be felt through the skin. . . . In the early stages (of tuberculosis) the parts of the udder which are affected are larger than usual and feel nodulated. As the disease advances the enlargement and induration increase, but in the later stages there may be absorption of degenerated tissues, contraction of fibrous tissue, and the udder may be considerably reduced in size."

"For some time after the onset of tuberculosis in the udder, the lesions are so slight that even an experienced veterinary surgeon may have great difficulty in deciding whether the udder is diseased or not."

Dr. Delépine recommends that a sample of milk should be taken from each teat, and submitted to bacteriological examination in all cases of difficulty.

Methods used for the Detection of Tubercle Bacilli in the Laboratory.—"The presence of tubercle bacilli in tuberculous products may be ascertained by three methods: (1) The microscopical method; (2) The cultivation method; (3) The inoculation or experimental method. The cultivation method is uncertain, more especially where tubercle bacilli are associated with other organisms. The microscopical and the inoculation methods are at present the only ones suitable for serial work."

"Simple microscopical examination yields a certain proportion of trustworthy positive results, but negative results cannot be relied upon. The inoculation method, which gives much more accurate results, involves a delay of ten to twenty days."

"After many attempts I have not succeeded in finding a method

of microscopical examination, by which it would be possible to prove with certainty that *samples of mixed milk* collected at railway stations were entirely free from tubercle bacilli. On the other hand I have satisfied myself that by taking certain precautions, *it is generally possible by the microscopical method to determine rapidly whether tubercle bacilli are present or not in the unmixed milk obtained direct from the cow.*"

Results Obtained

Number of Tuberculous Farms at Various Times during the Eleven Years.—"In comparing various periods it was necessary to deal with a fairly large number of cows for each period. In order to get figures of considerable magnitude I have been obliged to group together all the farms tested during the years 1896 to 1900. The number of farms tested in each of the years 1896, 1897, 1898, was too small to reduce sufficiently the effects of hazard, and permit the results obtained during each of these years to be compared with those obtained in the following years. The actual state of the farms in 1896 was worse than the figures relating to the four years 1896 to 1900 indicate. (Samples of mixed milk were not examined during 1899.)

"The number of farms tested and found tuberculous between 1896 and 1908 was as follows:—

Year.	No. of Farms Tested.	No. of Farms Tuberculous.	No. of Farms Tuberculous per cent of Farms Tested.
1896–1900 (four years)	427	72	16·8
1901	368	44	11·9
1902	348	41	11·7
1903	339	44	12·9
1904	331	38	11·4
1905	571	48	8·4
1906	555	48	8·6
1907	549	40	7·2

"The number of tuberculous farms has therefore been reduced by more than one-half."

Number of Samples of Mixed Milk coming into Manchester that were found Tuberculous.—"The number of samples examined during each of the years 1897 and 1898 is unfortunately too small for comparison. By throwing these two years together one gets a total of 110 samples, 19 of which were tuberculous, *i.e.* 17·2 per cent."

"No mixed samples were taken in 1899. The percentage of tuberculous samples for each of the ten years is as follows:—

	Per cent.
1897–1898	17·2
1900	11·1
1901	9·7
1902	8·9
1903	11·8
1904	10·1
1905	7·9
1906	6·6
1907	5·9

"It will be noticed that these figures agree closely with those relating to the number of tuberculous farms during the same periods. The reduction in the amount of tuberculous milk supplied to Manchester can therefore be fairly attributed to the reduction in the number of tuberculous farms. I have previously shown that the reduction in the number of farms producing tuberculous milk was mostly, if not entirely, due to the *elimination of cows with tuberculous udders.*"

Liverpool

The condition of the Liverpool milk supply in relation to tuberculosis is also instructive. That city appears to obtain about half of its milk from cows kept within the city, and the other half from cows kept in the country which is sent into the city by rail. That part of the milk supply derived from the town cows has become practically free from tuberculosis. Dr. Hope attributes this result to the sanitation of the cowsheds, the adequacy of air, light, and cleanliness, systematic and frequent inspection of the cows by qualified inspectors with veterinary assistance, and by frequent bacteriological analysis of the milk. The country milk is, on the contrary, more or less frequently tuberculous —indeed it may be said that the tubercle bacillus is found more than twice as often in samples of milk from the country than from the town.

London County Council

The London County Council carry out periodic veterinary inspections of the milk cows stabled in the metropolis. During the year 1908 five inspections of all the cows in the London cowsheds were made. Sixteen cows suffering from tubercular disease of the udder were discovered and slaughtered, compensation being paid by the Council to the owners in accordance with the provisions of the London County Council (General Powers) Act of 1904. Under the London County Council (General Powers) Act, 1907, Part IV, samples of milk were taken from milk churns coming from the country and submitted to bacteriological examination, and where positive results were obtained, a clinical examination of the cows at the dairy farm from which the milk had been consigned was made by a veterinary inspector appointed for the purpose.

CHAPTER II

Other Diseases that may be Transmitted by Milk

Anthrax—Foot-and-mouth Disease—Pleuro-pneumonia—Garget—Enteric Fever—Diphtheria—Scarlet Fever—Sore-throat Illness—Epidemic Diarrhœa.

Certain diseases of the cow have an influence on the milk.

Anthrax.—It is fortunate that the secretion of milk is arrested in cows suffering from anthrax, and this fact obviates to a great extent the risk of this disease being transmitted by milk.

Foot-and-mouth Disease.—The milk of cows suffering from this malady, when pustules appear on the teats, may give rise to the disease in those who consume it. The writer knows of a case in which the disease appeared in the children of a family who kept two cows in a stable attached to the establishment. On investigation it was found that the cows were affected, and that the disease had been transmitted to the children by means of the milk. The milk of cows with foot-and-mouth disease should not be sold for human consumption, nor even be employed for feeding pigs or other animals till it has been thoroughly boiled.

Pleuro-pneumonia.—Cows affected with this disease are said to be able to transmit it to those who ingest their milk. Luckily this malady is seldom met with in this country at the present day.

Garget, or "**Weeds**" as it is often called by farmers, is an inflammatory condition of the udder, attacking one or more quarters, and generally following injuries, blows, &c. The

affected quarters are swollen, hot, and very painful, and the milk drawn from them is curdy and may contain pus or blood. The cow's temperature also becomes raised.

Milk derived from animals in this condition may give rise to gastro-intestinal disorders, especially in infants or young children.

All febrile disturbances in the cow injuriously affect the milk, which should never be sold while the animals are in this condition.

The injurious effect of colostrum upon the consumer has already been alluded to. The milk of goats has been shown, under certain circumstances, to be capable of transmitting Malta fever, though the correctness of this observation has recently been called in question. Goats fed on meadow saffron have been known to induce severe diarrhœa in those consuming their milk.

The most important milk-borne diseases, apart from tuberculosis, are enteric or typhoid fever, diphtheria, scarlet fever, sore-throat illness, and probably epidemic diarrhœa. Whether such diseases as measles, smallpox, or whooping cough are conveyed by milk is open to question. The author succeeded in transmitting the latter disease to cats by feeding them on milk containing the sputum of patients suffering from whooping cough.

Enteric or Typhoid Fever.—A very large number of epidemics of this disease have been caused by an infected milk supply. Milk-borne epidemics of enteric are generally characterized by their sudden onset. A large number of persons are simultaneously attacked, or nearly so, and it frequently happens that two or more persons in the same household are taken ill at the same time. The outbreak is often of short duration, and comes immediately to an end as soon as the source of infection has been discovered and removed.

The manner in which the specific bacillus gains access to the milk is of great importance to all interested in the milk trade. The primary source of typhoid-fever germs is, of course, the typhoid-fever patient. The fæces of such a patient

contain the microbe in great numbers, the urine also is not infrequently infected, while, in cases with respiratory complications, the organism may be found in the sputum.

Milk may become contaminated with the bacillus typhosus in a number of ways. Should a person suffering from the disease come into direct contact with milk, contamination may easily take place. A typhoid-fever patient discharges the typhoid bacillus in large numbers from his body, and is liable to infect anything that he touches. If such a person works in a dairy, milks cows, or handles milk dishes, the germs from his hands or clothing may very easily enter the milk.

Sometimes the disease is of a mild type, which does not confine the patient to bed, and which may not be recognized as typhoid fever at all. Patients affected with this "ambulatory" form of the disease may continue for days or even weeks at work. Again, though in most cases of typhoid fever the patient becomes quite free from typhoid bacilli within a comparatively short time after recovery, in a small percentage of cases the germs may persist for months or even years. Persons who thus retain the specific bacillus become what are known as "typhoid carriers". The employment of such persons in a dairy would be a source of grave danger.

Infection of milk may also take place indirectly. If a person working in a dairy should at the same time nurse a typhoid-fever patient, or handle the discharges, or the soiled clothing or bedding of typhoid patients, and subsequently milk cows or handle milk utensils, contamination of the milk is very apt to occur. For this reason it is usual to forbid the sale of milk from any farm or dairy where there is a case of typhoid or other infectious disease.

Infected water may be the channel through which contamination of milk with the specific bacillus is brought about. If the discharges of typhoid-fever patients be improperly disposed of, if, for example, they are deposited on the soil, they may percolate through the ground and find their way into wells, springs, or rivers. Further, sewage sometimes drains direct into rivers. Water may thus, or in some other

way, become infected with typhoid bacilli, which are capable of remaining alive in it for a considerable period.

If such infected water be added to milk, or be used in washing milk vessels, or in cooling milk, contamination may easily take place. Sometimes milk-cans, after being scalded, are washed with cloths which have been rinsed in cold water. If such water be infected with typhoid bacteria, they may easily be introduced into the milk. One very severe outbreak of typhoid in America was caused by rinsing milk-cans in cold water after washing them in hot water. It is therefore of very great importance that every dairy should have a pure water supply, which is not in any way liable to contamination.

It is possible that infected dust or flies may occasionally be the means of introducing the typhoid bacilli into milk.

We have already seen that tubercle bacilli do not under ordinary conditions multiply in milk, but this is not true of the typhoid organism, which multiplies rapidly in that medium. Thus, if even a very small number of typhoid bacilli are introduced into milk, the conditions of growth are so favourable that, by the time the latter reaches the consumer, they may have become indefinitely numerous. It is probably this fact that explains the violence of milk-borne epidemics of typhoid.

It cannot, therefore, be too strongly impressed upon the dairyman, that milk must never be allowed to run even the remotest chance of infection with the germs of typhoid fever or with the contagion of any other infectious disease.

Diphtheria.—This is a disease that is also very frequently milk-borne. It is probable that the diphtheria bacillus generally gets into the milk by direct contact with persons suffering from the disease. It must also be remembered, however, that convalescents from diphtheria may retain the bacillus in their throats for weeks after their recovery, and that, should such persons be engaged in the milk trade, the milk may become contaminated. Probably articles of clothing and other materials may retain the infection for long periods.

Several outbreaks of diphtheria suggest very strongly that there may be a bovine form of the disease; Klein, indeed, believes that the specific bacillus is inoculable on cows, that it produces a specific eruption on the udder, and that the bacilli are excreted in the milk within five days.

Scarlet Fever.—Infected milk has been the cause of many outbreaks of scarlet fever. It is probable that milk generally becomes contaminated by direct contact with scarlet-fever patients. Newsholme called attention to the very important fact that, "Scarlet fever may be caused by infected milk containing the contagium in such an attenuated form or minute quantity that no symptoms manifest themselves except as anomalous sore throat with fever".[1]

Sir William Power, in 1882, suspected that there might be a bovine form of this disease, and his surmises were strengthened by the Hendon outbreak in 1885. In that year an outbreak of scarlet fever in Marylebone was found, on investigation, to be associated with a milk supply coming from a farm in Hendon. The same milk was also sold in St. Pancras, Hampstead, Hendon, and St. John's Wood, and scarlet fever suddenly broke out in each of these districts except the last. On a certain day some of the milk sent to Marylebone was returned to Hendon and distributed among the people there, with the result that a number of cases of scarlet fever occurred among the consumers, and at the same time there was a decrease in the number of attacks in Marylebone.

On investigation by Power and Klein it was found that there had been no case of scarlet fever among the employees at the farm. The cows were, however, discovered to be suffering, or to have recently suffered, from vesicles or ulcers upon the teats and udder. This condition was evidently infectious. It had been first seen upon a newly bought cow, but quickly spread to the other cows. It was noted also that scarlet fever broke out in each district a few days after the introduction of this affection into the cowshed from which the milk supplying the district was derived. No cases of scarlet fever among

[1] *Jour. Hyg.* (Camb.), vol. ii, 1902, p. 150.

users of the milk in St. John's Wood were at first notified. This was explained by the fact that the disease had not appeared among the cows in the small shed from which alone the St. John's Wood supply of milk was drawn. During the investigation, however, this shed also became affected, and an outbreak of scarlet fever in St. John's Wood immediately followed. As soon as the milk from the affected cows was stopped no more cases of scarlet fever occurred among consumers of the milk.

The vesicles on the teats and udders were at first small. Later they extended, and in two days formed flat irregular ulcers covered with brown scabs. There was no fever among the cows. Bald scaly patches about the tail and back were present in some cases. By cultivation, a streptococcus was obtained resembling that isolated by Klein in connection with scarlet fever. Calves inoculated with this organism suffered from a disease somewhat resembling scarlet fever.

Since the Hendon outbreak there has been much discussion as to whether scarlet fever may be derived from the cow, many authorities believing that no conclusive evidence of a bovine origin had been brought forward. Just recently Sir Shirley Murphy submitted a joint report by Dr. Hamer and Dr. Henry Jones on an outbreak of scarlet fever in London and Surrey, and a bacteriological report of the outbreak by Dr. M. Gordon, which throws more light on the question and goes far to confirm the conclusions arrived at by Sir William Power.

The following résumé of Sir Shirley Murphy's report is taken from *Public Health*:—

"The chief milk vendors among whose customers cases of scarlet fever occurred numbered twelve, the number of cases per vendor varying from 15 to 120. All the vendors obtained milk from one depot of a certain milk company having ten to twelve similar depots. This depot received milk from 31 farms, 3 of which, referred to as X, Y, and Z, were under suspicion of being concerned in spreading the infection.

"It was reported that at farm X there had been cases of

German measles, and at farms Y and Z cases of measles. The two latter farms were, however, quickly cleared of suspicion. The cases there were undoubtedly suffering from measles, and it was found that these farms had not supplied milk to some of the implicated vendors.

"Milk from farm X had been supplied to all implicated vendors; and at the cottage of a farm carter, who also acted as milker. The investigators discovered that the supposed cases of German measles consisted of two cases of undoubted scarlet fever and three cases of sore throat. There, it may be thought, was the source of the outbreak, but the first of these cases was taken ill on June 11, while the outbreak began in Surrey on June 7. The milk from farm X was infective four days before the cases occurred in the carter's family, and enquiry failed to reveal any other cases of scarlet fever.

"Attention was directed to the cows at farm X, and they were examined by Mr. Dunbar, the Veterinary Surgeon of the London County Council, who found that most of the cows presented scabs and excoriations on the teats and udders, the lesions being similar to those described by Sir William Power in what is known as Hendon disease. The lesions were most marked in a red heifer that had calved about May 24. The calf died four to five days after it was born, and it appears likely that the milk of the red heifer first came into use on June 7, the day on which the first cases of the outbreak began. Drs. Hamer and Jones suggest that the milk of this animal had a special pathogenic quality, which possibly gave rise to the death of her calf, and subsequently to scarlet fever among the human consumers of her milk. This hypothesis still leaves the origin of the disease in the red heifer to be accounted for, and it is suggested *faute de mieux* that she was infected by food."

Sore-throat Illness.—A number of outbreaks of sore throat have been found to be conveyed by milk. These sore throats seem, in some cases, associated with, or even to be, a mild form of scarlet fever, and in others to resemble diphtheria.

Among the more recent outbreaks of this nature may be

mentioned those which occurred at Bedford in 1902, at Woking in 1903, at Finchley in 1904, and at Colchester in 1905. In the Woking epidemic the milk was derived from cows suffering from suppurative mammitis. In *Public Health* for September, 1904, Chalmers records "An outbreak of (? septic) sore throat among the staff at Belvidere Hospital, which coincided with the occurrence of a teat eruption in the herd supplying the milk". Robertson, also, in the January number of the same year records another outbreak.

Outbreaks of scarlet fever, diphtheria, and sore-throat illness brought about by milk derived from cows suffering from some form of eruption on the teats and udders would seem to imply that there may be bovine forms of these diseases. While it is very likely that this may be the case, another explanation seems possible, namely, that the cow's teat forms, upon occasion, a convenient culture medium upon which the organisms of specific diseases may be inoculated by the hands of the milkers or otherwise. Were a small abrasion present on the teat, it can readily be imagined how easily inoculation would be effected, and did the organisms grow and flourish on the teat the milk would almost inevitably in the process of milking become contaminated with them.

Epidemic Diarrhœa.—This disease is of peculiar interest to all those who have anything to do with the public milk supply. It is most prevalent and most fatal in autumn, more especially if the weather be warm and the rainfall low. High temperatures and dust are essential factors in its causation, and the part that these play in the contamination of milk is of great importance to us. The mortality among infants fed on the breast is much less than that obtaining among artificially fed babies.

We owe much to the researches of Newsholme for our present knowledge of the disease. Three of his conclusions may be quoted.

1. Epidemic diarrhœa is chiefly a disease of urban life.

2. Epidemic diarrhœa as a fatal disease is a disease of the artisan and still more of the lower labouring classes to a

preponderant extent. This is probably largely a question of social status *per se*; that is, it is due to neglect of infants, uncleanly storage of food, industrial occupation of mothers, &c.

3. The fundamental condition favouring epidemic diarrhœa is an unclean soil, the particulate poison from which infests the air and is swallowed, most commonly with food, especially milk.[1]

The same authority holds that the ordinary sporadic cases of diarrhœa, affecting children in large numbers in urban districts, are due "chiefly to domestic infection of milk and other foods, or to direct swallowing of infective dust". He believes, further, that the bulk of infection in epidemic diarrhœa is derived in some way within the house and not from the farm.[2]

These conclusions are of the greatest importance, and demonstrate the need for greater care being exercised in the care of milk in the houses of the consumers—more especially in those of the lower classes.

Vincent believes that the putrefactive changes which occur in boiled or diluted condensed milk (that has been deprived of the lactic acid organisms) are responsible for the production of epidemic diarrhœa. He goes on to say:—

"The fundamental characteristic of the natural food of the infant is that it is a raw fluid. In all circumstances the cooking of milk for the use of infants gravely impairs its nutritive value. With regard to zymotic enteritis, no serious amelioration in the mortality arising from this disease can be anticipated until the fullest protection of pure raw milk is secured for every infant, and special precautions must be taken, at times when heat and dust are prevalent, to secure that the milk for the use of infants shall be preserved fresh and unboiled."

We believe personally that the use of artificially soured milk, which is at present coming into popular favour, or a modification of it, would be most useful in the prevention of

[1] *Public Health*, 1899–1900.

[2] "Domestic Infection in relation to epidemic diarrhœa," *Jour. Hyg.* (Camb.), vol. vi, 1906, p. 139.

epidemic diarrhœa. The writer has seen many cases of this very fatal disease yield to the use of buttermilk when all other remedies had failed. It was administered to the infants in ordinary feeding bottles, and had the effect not merely of checking the diarrhœa but of improving the nutrition of the child. If municipal depots where milk is prepared for infant feeding, or private dairy companies, would turn their attention to the production of suitably soured milk, and if the public could be persuaded to adopt it, we believe that a very marked reduction in the infantile mortality of our large cities would result.

Such sour milk, containing a large number of lactic acid bacilli, would not be so easily contaminated in the homes of the consumers, because these bacilli are antagonistic to putrefactive organisms, which cannot grow in the acid milk. It has been stated that infants fed on sour milk are prone to digestive troubles and diarrhœa. This has not been our experience. We have found, on the contrary, that they thrive and derive great benefit from it.

CHAPTER III

Dairy Methods in Relation to the Contamination of Milk

In the Byre—The Cow—Importance of Grooming—Moistening the Udder before Milking—Covered Milk Pails—The Milker—Methods of Milking—Training of Milkmaids and Dairymen—Milking Rooms—Milking Machines—Contamination from Air of Cowshed.

At the Dairy—Dairy Utensils—Importance of Proper Methods of Cleaning—Filtering or Straining of Milk—Centrifugal Force as a Method of Cleansing Milk—Cooling of Milk—The Refrigerator—Effects of Low Temperatures on Milk—Tyrotoxicon Poisoning—The Refrigerator as a Source of Contamination.

Transportation and Delivery—Railway Churns—Cleansing of Milk Churns—Milk Cans—Glass Bottles—Paper Bottles.

Milk Shops—Proper Methods of Storing and Dispensing Milk—Suitability of Premises.

In the Home of the Consumer.

Improvement of Milk Supply by Private Enterprise—The Aylesbury Dairy Co.—The White Rose Dairy Farm, York.

Regulations with Regard to Milk Supply in New York City—American "Certified Milk".

IN THE BYRE

The Cow.—There has been much discussion as to whether the milk drawn from a healthy udder is sterile or not. Of course it is well known that, if the udder be diseased, it may give rise to micro-organisms in the milk drawn from it. Thus, in the case of tuberculosis of the udder, or mammitis, the milk is almost certain to become contaminated. Many authorities affirm, however, that even the milk from a perfectly normal udder may contain bacteria. They believe that micro-organisms can gain access to the milk ducts in the teat and multiply there, with the result that the milk first drawn contains an excessive number of micro-organisms

which are supposed to be washed out of the teat. It is quite true that the first-drawn milk contains far more bacteria than the rest of the milking, and is for this reason generally discarded by the milker, though whether the above-given reason is the true explanation is open to question.

The exterior of the cow, however, may contribute in no small measure to the contamination of the milk. Countless germs exist on the hair which covers her body, and many of them during milking find their way into the milk. It is no uncommon thing to find large amounts of dung adhering to the animal's flanks, tail, and udder. Such a state of matters, as might be expected, increases very markedly the number of organisms that fall into the milker's pail.

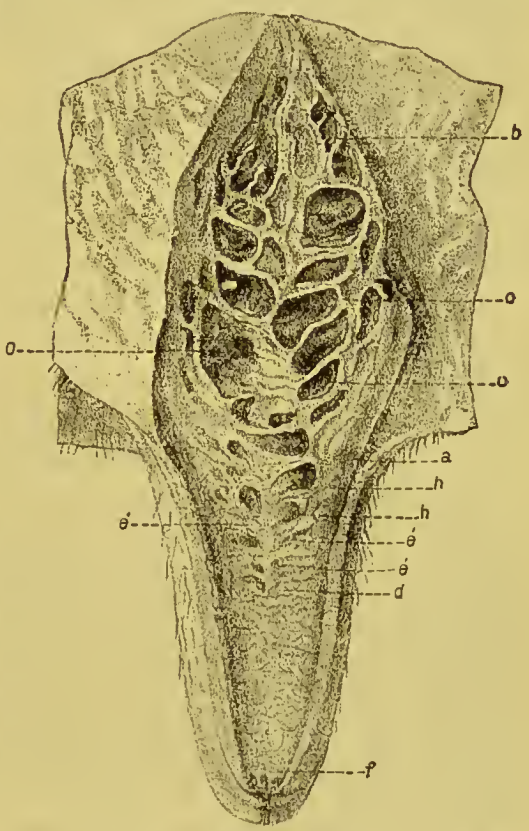


Fig. 1.—Milk-cistern and Outlet Tube of Milk-gland, laid open. Two-thirds of natural size

a, Basis of teat; *b*, upper end of milk-cistern; *d*, lower end of same and upper end of teat; *e'*, dilatation of canal of the teat; *f*, rosette on end of lower portion of canal of teat; *h*, small, and *o*, large gland-ducts. (Fürstenberg.)

Importance of Grooming.—In order to reduce such contamination as much as possible, cows should always be kept carefully groomed. All manure adhering to the hair should be removed by curry comb and brush—washing being employed if necessary. Care must be expended on the grooming of the cows if a proper milk supply is to be obtained.

Moistening the Udder before Milking.—Immediately before milking, the udder of each cow should be washed and left moist. When this is done the bacteria adhere to the moist surface and are less liable to fall into the milk. The udder should, however, not be left wet, otherwise the excess of moisture may drip down into the milk pail. An udder with a damp surface is what is desired.

It is commonly stated by farmers that the washing of the udder is apt to give the cow cold. If properly done, it has no prejudicial effect on the health of the cows. Orr washed the udders of cows in this fashion twice daily, during winter, without any harmful result. The author has also known of such treatment being carried out for long periods without prejudice to the health of the animals. There would, however, be no harm in the udders being dried with a clean towel as soon as the milking is completed, should this seem desirable to those in charge of the cows.

If, however, this washing is to be effectual, it must be carried out in a proper manner, otherwise it may do more harm than good. Thus, if one cloth be used to wash the udders of all the cows in a large byre, it will before long contaminate rather than cleanse them. Several cloths should be kept exclusively for this purpose. They ought to be boiled, dried, and stored in some suitable place between use, so that they may be clean and free from micro-organisms when required.

Covered Milk Pails.—The ordinary milking pail, with its very wide mouth, permits much dust and debris to fall into the milk. Special covered milk pails have, therefore, been designed with the object of as far as possible minimizing the amount of dirt which falls into the milk during milking. There is considerable variety in the style of such vessels, but the plan in all is the same, to decrease the size of opening and thus expose less surface for the entrance of dirt. In order to reduce contamination yet further, the milk is made to pass through a very fine wire-gauze strainer, or one made of linen, or sterilized cotton wool, placed in the opening in

the lid of the can. If cloths be used for strainers, they must always be sterilized before and after use; if cotton wool be employed, it must be destroyed after each milking.

Conn states that the use of a covered pail keeps out about 66 per cent of the dirt that gets into the ordinary milk pail, and that it is one of the easiest, cheapest, and

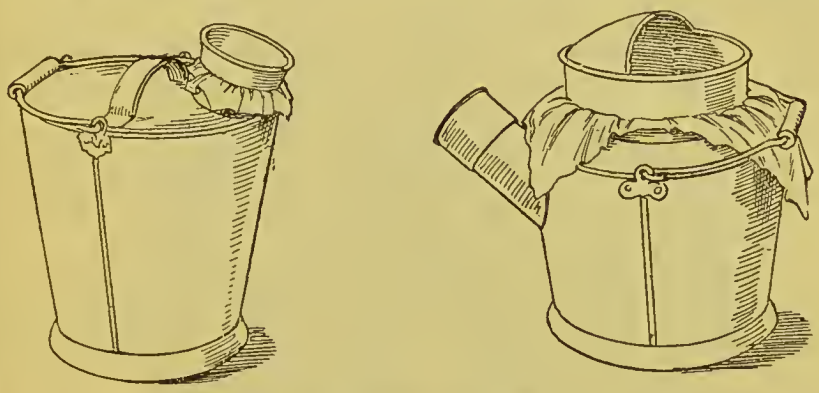


Fig. 2.—Covered Milk Pails

most efficient means at the disposal of the dairyman for improving the character of his milk.

The Milker.—The milker is another source of frequent contamination. Any person suffering or convalescent from certain infectious diseases, or having been in contact with others so suffering, who milks cows, is liable to transmit the disease to the consumers of the milk. In this way milk may become the vehicle by which scarlet fever, diphtheria, enteric fever, and a malady known as sore-throat illness, is disseminated. Indeed, a large number of outbreaks of these diseases have been traced to such a cause. Nor is it merely those commoner infectious diseases that have to be feared, because a milker suffering from tuberculosis—especially phthisis—or other contagious disease, may be the means of spreading it in a like manner.

Many people recommend the periodic inspection of dairy cattle, but strict medical supervision of milkers and those handling or in any way coming in contact with milk is a matter of no less importance; it is questionable, indeed,

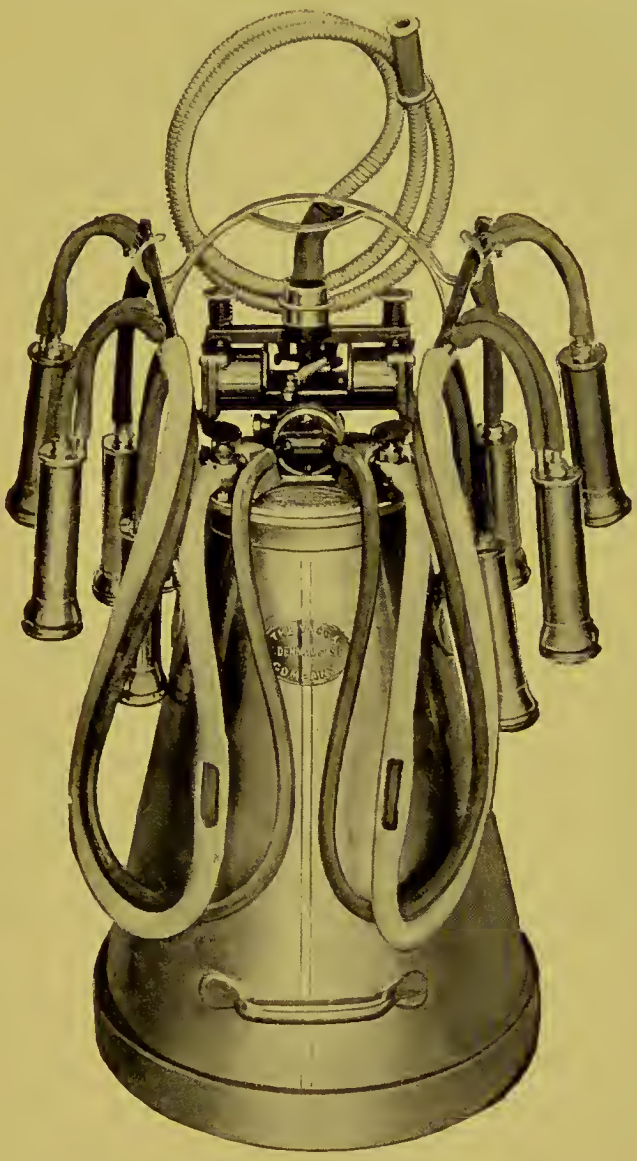
if such persons should not be licensed. In any case it is of the greatest consequence that milkers should be healthy persons, and every care should be taken that they do not come in contact with infection of any kind. Even if the milkers be healthy, the condition of their hands and clothing, which are in many cases none too clean, requires attention. Each milker should put on a clean white overall, made of some washable material, before milking commences, and if such clothing be sterilized each day, as is done in some dairies in America, so much the better. In the case of women the head should also be covered (caps ordinarily sold for bathing purposes furnish a cheap and suitable headgear).

Every byre should be furnished with running water, soap, and towels, to permit the milker to wash his hands after milking each cow, and whenever they are soiled; and strict watch should be kept to see that he does so.

It is important that the persons of dairy workers should be clean. This may seem a superfluous remark, but anyone possessing an intimate knowledge of existing conditions will understand why allusion is made to it.

Methods of Milking.—So-called "wet milking", in which the hands of the milker are kept moist by being periodically dipped in the milk, should not be allowed; because the contamination from the hands of the milker and the teats and udder of the cow is much greater when this method is practised than when the dry method of milking is adopted. Milkers should never dip their hands in the milk nor moisten them in any way, as such a practice is quite unnecessary. Needless to say, the very disgusting habit of spitting on the hands before commencing milking should not be tolerated.

Training of Milkmaids and Dairymen.—It is very unfortunate that the employees in most dairies have not received any adequate training to fit them for the work which they have to perform. Such persons are generally grossly ignorant even of the most ordinary facts concerning the product which



LAWRENCE-KENNEDY MILKING MACHINE

they handle, and they very frequently do not realize the danger which may accrue to the consumers of the milk as a result of carelessness on their part. It is to be hoped that the agricultural colleges will take this matter up and formulate some scheme for training milkmaids and dairymen, so as to enable them to perform their work in an intelligent manner.

Milking Rooms.—In connection with some up-to-date byres what is known as a "milking room", separated from the stalls in which the cows are kept, is provided. The cows are taken from the byre into the milking room, are milked, and then returned to the byre again. It is, of course, possible to keep the milking room in a state of far greater cleanliness than the byre, and it is stated that where such a system has been adopted the quality of the milk has been markedly improved.

Milking Machines.—There have been many attempts made to produce a machine that would milk cows in a satisfactory and efficient manner. Most of the earlier milking machines were a failure, and their use had, in most instances, for one reason or another, to be abandoned. Many improvements have, however, been introduced, and it seems likely that in the near future milking cows by machinery will cease to be looked upon as a novelty.

Description of the Lawrence-Kennedy Universal Milking Machine.—The Lawrence-Kennedy may be taken as a type of the modern milking machine, and a short description of it may not be out of place. (See Plates I and II.)

This machine milks the cows by a vacuum process. The vacuum is obtained by means of a small double-action pump, which is worked by an oil engine. There is a tank for the storage of vacuum. A line of galvanized-iron piping connected with the pump and storage tank runs along the whole length of the byre. A tap is placed on this pipe over the centre of each stall. The milk cans, when in use, are connected by means of rubber piping with these taps. Each can is also provided with rubber tubes ending in special cups for attachment

to the teats of the cow. When milking is about to commence, a can is placed between two cows, and, there being two sets of teat cups in connection with each can, two cows are milked simultaneously. The oil engine is then started, and very soon sufficient vacuum is produced to exhaust the air from and draw the milk into the can.

In most former milking machines the suction action was continuous, and this was found to have a harmful effect on the cow. In the Lawrence-Kennedy milking machine this difficulty has been got over by fixing a mechanical device known as a "pulsator" on the lid of each can, which causes the vacuum to act intermittently, thus imitating the sucking action of a calf.

Sight tubes made of glass are let into the rubber tubes which connect the cow with the can, so that those in attendance may be able to see when the milk ceases to run from the cow.

The vacuum in each set of teat cups is regulated by an inlet air valve, while there is a gauge in the byre to indicate the degree of vacuum in the tubes as a whole.

Such a machine, which draws the milk directly from the cow's teat to closed sterilized milk cans, without allowing it to come in contact with the air or exposing it to other forms of contamination, should produce a very pure milk.

Cleansing of the Apparatus.—This is accomplished very simply by making use of the action of the vacuum. The apparatus is attached to the vacuum tube from the engine, the teat cups are put into boiling water, which is drawn through the tubing, &c.; thus cleansing may be effected in a satisfactory manner. This is an all-important part of the process, because, were it not possible to keep the machine thoroughly clean, the results obtained from it would be worse than those got by the ordinary process of milking.

The author, having seen some of the older machines, which worked on the continuous-suction principle, was much impressed by the superiority of the Lawrence-Kennedy over these older types. Farmers at whose farms this machine

LAWRENCE-KENNEDY MILKING MACHINE IN OPERATION

has been in use for considerable periods seem strongly in its favour, and state that no ill effects on the cows' teats or udders have resulted from its use, nor has the yield of milk been less.

Milking by machinery does not, however, entirely do away with the personal element, and those in charge of the machine will require to be persons of intelligence, thoroughly drilled in the principles of cleanliness, if the best results are to be obtained.

Certain bacteriological experiments with milk drawn from the cow by milking machines have given very disappointing results. This may be attributed either to want of care and attention in the cleaning of the machine, or else to teat cups falling off the teats (as not infrequently happens from carelessness), thus permitting dust and debris from the floor of cowshed to be sucked into the machine.

Contamination from the Air of the Cowshed.—The air of a cowshed always contains a certain number of organisms. It is the duty of the dairyman to reduce the number as much as possible, and this may be done by paying attention to the following points. The cleaner the byre the fewer organisms will its atmosphere contain. Dung should be removed as frequently as possible. It should not be accumulated just outside of the byre, but should be taken away some considerable distance from it. The byre itself should be kept in as clean and sweet a condition as possible, the walls and ceilings being periodically cleaned; and spiders' webs, which accumulate dust, should be got rid of. Frequent whitewashing is useful, as it disinfects and renders the byre light, clean, and wholesome.

The number of micro-organisms which the air contains is, in the presence of dust, very much increased. Every care should therefore be taken to avoid the raising of dust immediately before and during the time that milking is going on. The feeding of cows is apt to fill the air with dust; it is obvious, therefore, that their feeding should follow rather than precede the milking process. The bedding of the

animals should, for a similar reason, not be disturbed during milking time.

Again, as soon as the milk is drawn from the cow it should immediately be removed from the cowshed to the dairy, and not be left standing in an open can on the gangway where dung, urine, &c., may be spattered into it.

AT THE DAIRY

Dairy Utensils.—All vessels used for the reception and storage of milk should be made of an absolutely unabsorbent material, otherwise it is impossible to thoroughly clean them. Needless to say, wooden vessels should never be employed for the purpose.

Most dairy utensils are made of tin, sometimes enamelled. Such dishes are excellent, provided they are jointed in a proper manner, and made so that all parts are readily accessible for cleaning.

All milk dishes should be cleaned immediately after use, and on no account should milk ever be allowed to dry upon them. The cleansing is best accomplished by first washing them in cold or tepid water, afterwards using hot water, and finally boiling them in a boiler used for the scalding of milk dishes and nothing else. Or if steam is available, the vessels can be inverted over a steam jet and subjected to the action of naked steam, which is best of all. It is very important that the final boiling or steaming should be carefully carried out, as it is on these processes that we depend for the destruction of the many forms of germ life, which may be dangerous to the consumer, and are prejudicial to the keeping qualities of the milk. After cleansing, milk vessels should be put in an airy position with the mouth or opening turned downwards, but in such a manner that the air has unrestricted access. Care must be taken that cats or other farm animals do not come in contact with them while left to cool in this manner.

Filtering or Straining of Milk.—While, as already pointed

out, the object should be, by carefully grooming the cows, by washing their udders, and by care and attention to cleanly methods of milking, to prevent the entry of foreign matters into the milk, yet, even under the most careful treatment, a

Fig. 3.—The Ulax Milk Filter consists of a conical funnel ending in a short cylinder, just above which is a ledge supporting two gauze metal discs which act as strainers. Between the strainers is placed the filtering medium, which is a tasteless, sterilized, prepared cotton. The strainers are kept in position by a cup-shaped lid provided with apertures to allow the milk to pass through, the whole being kept in position by means of a curved cross piece, which acts as a spring. Immediately after each filtering operation, the prepared cotton should be burned, fresh sterile material being employed on the next occasion.

certain amount of undesirable material will gain access to it. The use of a filter or strainer is therefore desirable.

It cannot be too strongly insisted upon, however, that a filter, no matter how efficient, merely gets rid of the grosser sediment, leaving the micro-organisms which have been separated from the sediment in the milk. When particles of dung

fall into the milk they dissolve slowly, polluting it with the organisms which they contain. It is very important, therefore, in the first place, to prevent as far as possible the entrance of such material, and in the second to get rid of what has gained entrance as rapidly as possible, as the longer it remains the greater will be the contamination. Milk should therefore be strained as soon as it is brought into the dairy from the byre.

Many forms of strainer are used; but whatever material—gauze, muslin, linen, flannel, &c.—be employed, care must be taken that it has been sterilized before use. Sterilized cotton wool makes a much more efficient strainer than any other material: it should be renewed each time the filter is used, and can be bought (sterilized ready for use) for a small sum.

Centrifugal Force as a Method of Cleansing Milk. — In some dairies, separators are employed for the purpose of cleaning milk. In the drum of a separator, milk is subjected to centrifugal action by means of which it is separated into two layers—the outer being milk and the inner or central cream. By means of an ingenious arrangement, the cream escapes by one exit tube, while the milk is discharged through another. In the process of separation, a sediment forms on the wall of the bowl, which is termed "slime". This slime consists of dirt particles, epithelial cells from the milk ducts, mucous or pus cells, and bacteria.

Separators can be specially fitted for the purpose of purifying milk. The machines, when arranged as milk-purifiers, deliver the milk unseparated, retaining in the separator bowl all the sediment, but not in any way altering the composition of the milk.

Swithinbank and Newman state that "mechanical separation results in 'filtering' the milk of many of its bacteria and driving them into the sediment which is discarded. The bowl sediment, therefore, contains the majority of the organisms, the separated milk being next in order, and the separated cream containing fewest organisms". The same authors state, however, that separation cannot be relied upon for

SEPARATOR FITTED FOR THE PURIFICATION OF MILK

removing all the disease-producing germs from milk. They conducted experiments which showed that, although considerable numbers were removed with the slime, some remained in the separated milk and cream. Thus, though centrifugal force is one of the best available methods of cleaning milk, it does not render that fluid free from tubercle bacilli or other harmful bacteria which it may contain.

Cooling of Milk.—As soon as the milk has been strained it

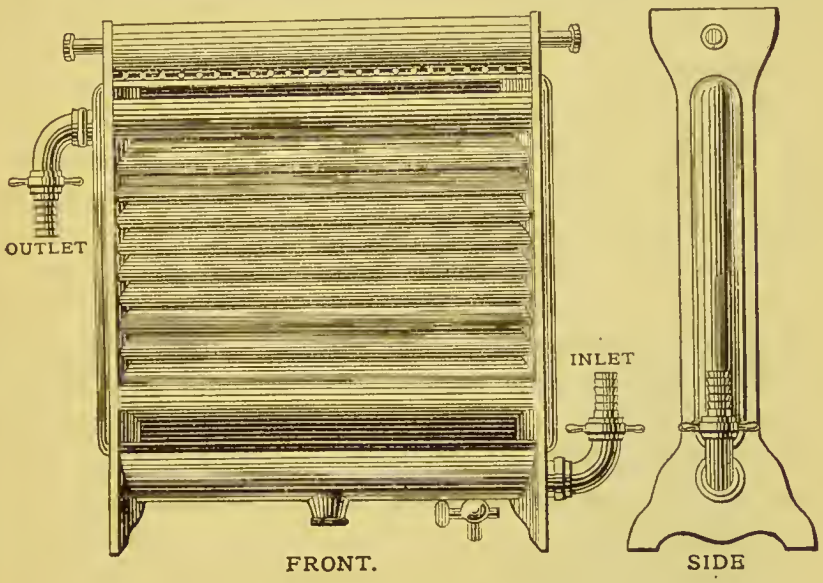


Fig. 4.—Ordinary Type of Refrigerator

should be cooled. This is generally effected by passing it over a refrigerator.

Refrigerator.—There are several different forms of this instrument now on the market; all consist essentially of a coil of pipes, over the surface of which the milk is made to flow in a thin film-like stream from above downwards, while cold water (to which ice may be added) traverses the interior of the pipes from below upwards. In this manner the milk trickles over the coldest part of the refrigerator last, and thus leaves the instrument at as low a temperature as possible.

Effect of Low Temperatures on Milk.—Low temperatures

have a very beneficial effect on the keeping qualities of milk, because, though they do not kill micro-organisms, they render them inactive and torpid, so that they are unable to multiply or produce their characteristic effects. Thus it is said that if milk be rapidly chilled—within five to fifteen minutes after milking—its souring will be retarded for from twelve to thirty-six hours.

Even if disease-producing germs be present in the milk, the cooling process will prevent or retard their multiplication, so that the number swallowed by the consumer will be reduced to a minimum.

Rapid cooling, especially in hot weather, is absolutely essential if the milk has to be sent any distance by road or rail. If not chilled it is apt to become sour, curdled, or to undergo fermentation, with the production of an alkaloid known as tyrotoxicon, which is exceedingly poisonous.

Tyrotoxicon Poisoning.—Vaughan was the first to isolate this poison in connection with cases of milk poisoning in America. Twenty-four persons at one hotel and nineteen persons at another were seized with the same form of sickness. The symptoms in most cases consisted of gastro-intestinal irritation, nausea, vomiting, cramps, and collapse; a few had diarrhœa; while a dryness in the throat and a burning sensation in the œsophagus were also prominent symptoms.

All the persons affected had partaken of milk to supper. On tracing the milk to its source, it was found that the cows at the farms from which it was obtained were milked at the unusual hours of noon and midnight. The noon supply, which was responsible for the illness, was placed while warm in the cans, and then without any attempt at cooling was carted 8 miles during the warmest part of the day in a very hot month to its destination. On analysis, tyrotoxicon was isolated, and Vaughan is of opinion that the improper care of the milk had much to do with the illness which it produced.

The Refrigerator as a Source of Contamination.—The refrigerator may, especially if used in dusty places, be a source of contamination. During its passage over the refri-

gerator the exposed surface of milk is of course very large, and organisms and dust floating in the air are very liable to fall into it. Refrigerators are very often cleaned immediately after use, and are left exposed for many hours to the air before being used again. Thus their surfaces become covered with organisms, which are removed and taken up by the milk when the refrigerators are again put into operation.

Much of this contamination might be avoided if coolers were fitted up and used in suitable premises kept very clean and possessing a moist atmosphere, and if they themselves after being cleaned, and in the intervals between use, were covered over with sterile cloths to prevent contamination of their surfaces.

TRANSPORTATION AND DELIVERY

Railway Churns.—These are the receptacles in which the milk is conveyed from the farm to the milk shop. They are too often constructed in such a manner as to afford little or no protection to the milk. Their tops are frequently made funnel-shaped, thus offering a large surface for the accumulation of dust, dirt, and rain; their lids seldom fit tightly, with the result that much foreign matter enters the milk. The rim over which the milk is poured in emptying the can is often unprotected by the lid, and thus becomes soiled by the dirty hands of those handling the churns. A churn should be made with an upright neck, which fits into an enclosing cover so constructed that the rim over which the milk is poured may be kept clean.

Fig. 5.—Ordinary Type of a Railway Churn

Again, many lids are provided with ventilation holes, because it is supposed that the free circulation of air prevents the souring of the milk. It is probable that such holes hasten rather than retard the souring process—by admitting dust and absorbable vapours. The fact that in America milk is

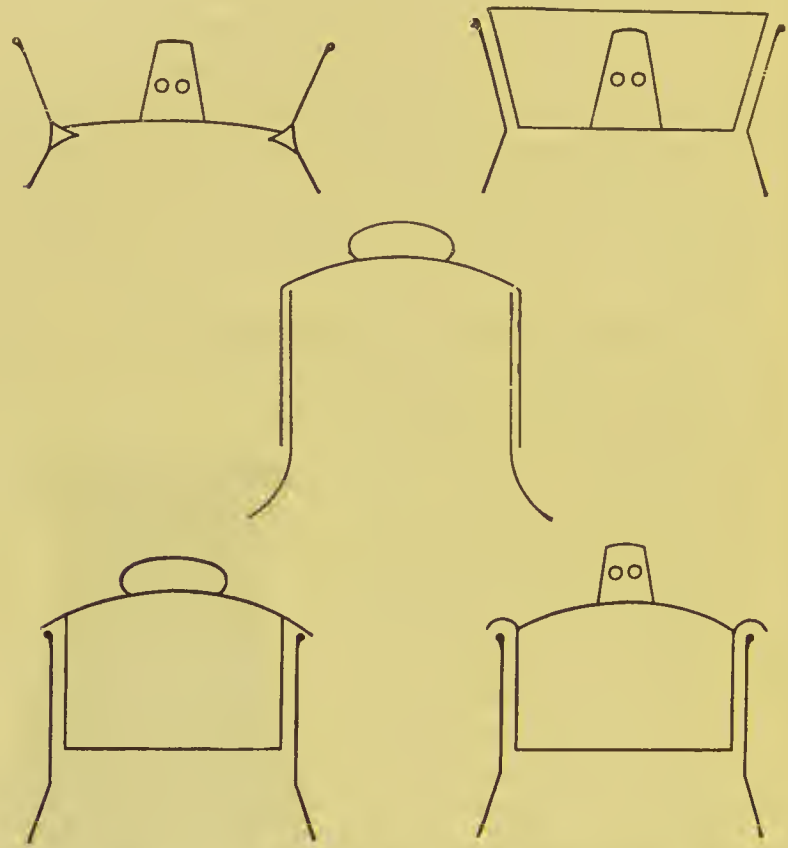


Fig. 6.—Outlines of Heads of Milk Churns. The construction of the two upper is unsatisfactory; the lower are better; that in the centre is best.

transported in dust-proof receptacles demonstrates that ventilation holes are quite unnecessary.

All churns should be locked and sealed before leaving the farm, so as to make it impossible for the milk to be tampered with during transit. The habit also of pouring milk from one can to another at dusty railway stations and other unsuitable places should not be permitted. Many milk churns,

as a result of rough usage, become battered, so that it is impossible to clean them satisfactorily by any ordinary method of cleansing. Such churns become a source of much trouble.

The Board of Agriculture and Fisheries, in a circular to makers of churns in Great Britain, point out that the railway companies do not object to carry milk in sealed churns, provided that the tare weight (the weight of the empty churn) is stamped on the outside of the churn. They further suggest that the following points be kept in view in connection with the construction of milk churns:—

1. The churn should have the tare weight stamped on the outside.

2. The lid of the churn should be constructed so as to facilitate sealing.

3. The churn should be constructed so as to prevent, as far as possible, the removal of milk from the churn while sealed.

4. The churn should be constructed so as to prevent water being added to the milk in the churn while sealed.

5. The churn should be constructed so as to prevent dust or dirt from being blown or washed into the churn when the lid is affixed.

Fig. 7.—Battered Milk Churn

Churns are now on the market with ice chambers fitted to the inner lid, which keep the milk cool right up to the time of delivery, even during the hottest days of summer.

Cleansing of Milk Churns.—When milk is sent by a farmer into milk shops, the churns should always be thoroughly cleansed and sterilized before being returned. Dairies provided with steam jets and other appliances can carry out this process much more thoroughly than the farmer.

Further, if the churns be not cleansed at the dairy, the organisms in the little milk left at the bottom, after emptying, multiply rapidly, and it is difficult for the farmer, under these circumstances, to adequately cleanse them afterwards, except by plunging them into boiling water. In large farms a steam

supply is of great use for all such purposes, sterilization being carried out much easier and with greater effieiency.

As it is a matter of very great importance to the health authorities that they should, on the outbreak of infectious disease, be able rapidly to trace milk from the consumer to its source, all milk should be sent to the dairy in sealed cans bearing the name of the farm where it was produeed, and, if mixing of two or more sources is necessary in order to obtain a milk of average quality, the dealer should label the mixture with the names of the farms concerned.

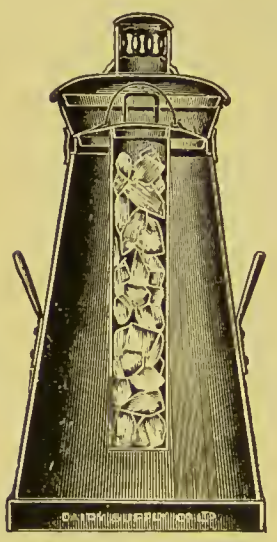


Fig. 8. — Delivery Churn, with ice chamber fitted to the inner lid

Milk Cans.—A great deal of milk is still delivered to customers in milk cans. This is unsatisfactory, as it is easy to tamper with the eontents of these utensils, and, owing to the lids being often ill-fitting, dust and dirt may readily get into the milk. Further, in this mode of delivery, milk is poured from vessel to vessel—often in the open street—and is very liable to contamination thereby. Milk cans are generally carried from door to door by children, many of whom are uncleanly in their personal habits, and there is always the chance that the juvenile earriers may be suffering from some infectious disease.

Glass Bottles.—It would be very desirable if milk, having been carefully strained and chilled, could immediately afterwards be emptied into well-cleaned sterilized bottles for distribution to the consumers. Such bottles should be hermetically sealed before being sent out, to prevent them being tampered with. Dairymen often affirm that the trade in bottled milk has been a failure; the reason for this being that suffieient attention has not been paid to the eleaning and sterilizing of the bottles.

To clean bottles in a satisfactory manner, steam and

machinery are required, and it is only the larger dairies that can afford to fit up the revolving brushes and other apparatus necessary. Milk sold in bottles should be dated, so that the customer may know that it is fresh.

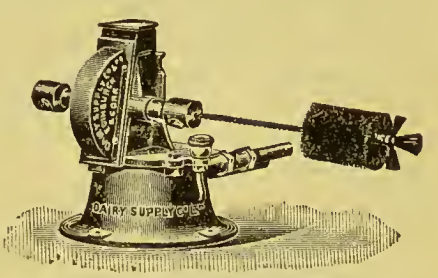
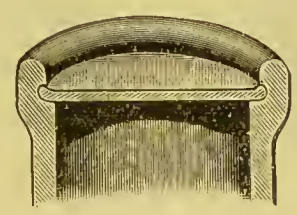


Fig. 9.—Steam Turbine Brush Machine

The type of bottle is a matter of great importance. The "disc" bottle is at present a favourite with many dairymen. Such bottles are generally made with a wide mouth, which is closed by means of a "fibre disc", supported by a slight ledge inside the neck of the bottle. The disc, which is not as a rule sterilized, is easily pressed in with the hand, but does not hermetically seal the bottle. The entrance of dust and dirt is facilitated by the fact that the disc is placed in the mouth of the bottle a little below the top, forming thereby a lodgment for extraneous matter.



Neck of bottle with disc in position.

Fibre disc.

Fig. 10.—"Disc" Milk Bottle

The consumer has no guarantee that milk, delivered in such bottles, was bottled at the dairy. The discs are so easily affixed that milk from ordinary cans may be poured into bottles in course of delivery, and sold as dairy-bottled milk; indeed it is the custom of vanmen employed by certain dairy companies to carry discs in their pocket for this purpose.

A satisfactory milk bottle should permit of easy and

thorough cleansing. It should be sealed at the farm or dairy in such a manner that extraneous matter cannot possibly enter, and that tampering with the contents of the bottle, without detection, is impossible. The seal should be composed of material that may readily be sterilized.

The "Dan" bottle with patent "Crown" closure seems to satisfy such conditions. The crown completely covers the

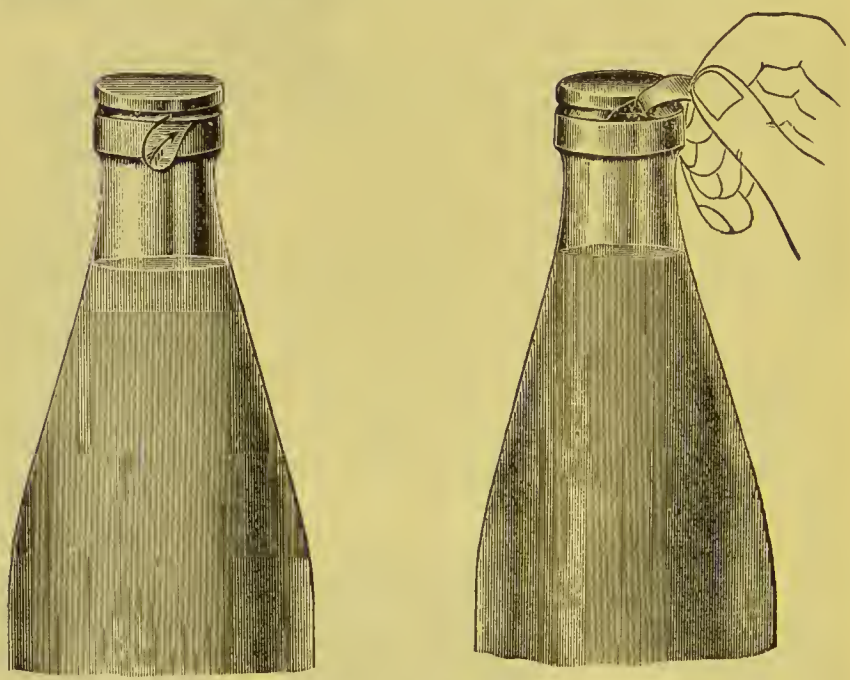


Fig. 11.—"Dan" Milk Bottle

mouth of the bottle, fitting into a groove on the outside of the bottle near to the top, thus giving a satisfactory closure. It is composed of pure aluminium, and is affixed by a special machine to the bottles with great rapidity. Removal is effected by tearing the crown off, after which it cannot be replaced as it is thereby destroyed, and thus bottles sealed in this manner cannot be tampered with after leaving the dairy.

Paper Bottles.—A new invention in the form of paper bottles has lately been put upon the market. They are

waterproofed with paraffin, and are supposed to be heated to a temperature which is sufficient to sterilize them. They are very cheap, and are intended only to be used once and then thrown away. It is too soon to say whether these bottles will be a success or not.

MILK SHOPS

Milk, as we have seen, requires to be handled with the greatest care and attention to cleanliness in the cowshed, at the dairy, and during transit, but the care with which it is treated must not end there, because even in the milk shop it may become contaminated.

Proper Methods of Storing and Dispensing Milk.—It is a common custom to store milk in open uncovered vessels placed on the counter, where it is exposed to dust and other forms of contamination. Customers are served from such receptacles by means of a small can which is dipped into the milk. This is a most unsuitable mode of keeping and dispensing milk. It would be far better were it put into churns with crans attached, so that customers could be served without the necessity of exposing it to contamination.

Suitability of Premises.—Again, the premises from which milk is retailed are not always satisfactory. Thus, it must be obvious that a general store, where all manner of goods are handled, does not commend itself for the sale of milk, which so readily takes up odours and even becomes flavoured by substances with which it comes into close contact. Further, it need scarcely be pointed out that the mangling of clothes, or any such operation, should never be permitted in any milk shop, nor should the latter be in direct communication with living or sleeping rooms, water closets, or the like.

The sale of such articles as butter, eggs, sweets, and even bread may quite properly form part of a dairyman's business, but the sale of milk and vegetables, for example, should not be carried on in the same shop.

The Regulations as to Dairies, Cowsheds, &c. (see pp. 137, 143),

lay down conditions in connection with milk shops which require to be complied with, and therefore it will be unnecessary to say more on the subject here. It is worthy of note, however, that a person desirous of starting business as a dairyman requires first to obtain a licence. The authorities have no power to refuse a licence to anyone who makes application; it is only if the person duly licensed starts business in unsuitable premises that they may refuse to allow him to continue. If the shop instead of the vendor were licensed the difficulty would be got over, as were it unsuitable the authorities could refuse to license it.

Contamination in the Home of the Consumer.—In small houses, especially those of only one room, where milk stands in uncovered vessels, it is open to contamination with bacteria and dust from a great many different sources. In such dwellings, where there is no pantry or larder, and where the milk stands uncovered in an apartment in which cooking, eating, sleeping, cleansing, &c., are all carried on, it will readily be seen how easily it may be contaminated.

Newsholme holds that the ordinary sporadic cases of diarrhœa, affecting children in large numbers in urban districts, are due "chiefly to domestic infection of milk or other foods, or to direct swallowing of infective dust". Milk, as soon as received from the dairyman, should be put into vessels which have previously been well scalded with boiling water. Such vessels when filled should be covered to prevent the entrance of dust and flies, and kept in a cool place until the milk is required for use.

IMPROVEMENT OF MILK SUPPLY BY PRIVATE ENTERPRISE

To show what may be accomplished by private enterprise in the improvement of the public milk supply, we desire to allude briefly to two concerns only—namely, the Aylesbury Dairy Co., London, and Mr. Sörensen's White Rose Dairy in Yorkshire.

AYLESBURY DAIRY COMPANY

The system adopted by the company may be given in their own words, as follows:—

Preliminary Precautions.—*Preliminary Medical Inspection.*—When a farmer offers to supply milk to the Company, he is furnished with a list of questions as to the sanitary conditions of the farm, &c. If the answers are satisfactory, the Company sends its Medical Inspector to inspect the farm. He is invariably the Medical Officer of Health for the District, and consequently is cognizant of the state of health of the locality, and has immediate knowledge of all cases of infectious disease. He makes, at the Company's expense, an exhaustive report covering the whole field of sanitation and drainage, the personal health of the farmer and his family, of the farm hands and their families, and also of the general health of the district. He also sends for analysis in the Company's laboratory, samples of the water used in the dairy for washing the utensils, and for refrigeration. The importance of this last precaution is shown by the fact that more than half the farms inspected are rejected because the water supply is polluted; the farms are only accepted if a new satisfactory water supply is provided.

Preliminary Veterinary Inspection.—The Company also instructs its veterinary surgeon to report on the health of the cows, each animal being individually examined for the purpose of ascertaining the existence of tuberculosis or any other condition likely to render the milk harmful. If an animal having tuberculosis or other disease likely to render the milk unhealthy is found, the Company requires that it be got rid of. If these reports are satisfactory, and the samples of water pass the test of rigorous analysis in the Company's own laboratory, we come to the

Permanent Precautions.—*Medical Control of Farm.*—The contract with the farmer having been signed, and definite business relations established, the Medical Officer of Health makes a *monthly* report and furnishes a certificate as to the sanitary condition of the farm, and of the health of the farmer, his family, his farm hands and their families, and of the dwellers in the district generally. He also forwards periodically further samples of water for analysis by the Company's chemist, and in the event of any pollution being discovered, the supply of milk from the farm to the Company is immediately discontinued.

Veterinary Control of Cows.—The local Veterinary Officer also furnishes a *monthly* report and certificate as to the health, general condition, and cleanliness of the cows. The Veterinary Officers work under a system devised by Sir John MacFadyean, Principal of the Royal Veterinary College, and report direct to him. Sir John Mac-

Fadyean supervises generally their work, and acts as consulting Veterinary Officer.

The Farmer's Self-Interest Enlisted.—The clauses and provisions of the contract ensure the purity and quality of the milk supplied; but by far the most important clause is undoubtedly that which binds the farmer under a penalty of £100 to cease immediately sending milk should any disease of a contagious or infectious character occur in his own family, in that of any of his employés, or amongst his cows.

Compensation for withholding Milk.—If the clause stopped at that point, it might reasonably be held that all requisite precautions had been taken. But as a matter of fact it goes much further, and enlists the farmer's self-interest on the side of sanitary protection, by binding the Company to pay the farmer exactly the same price for the milk, when so withheld, as it would have done if there had been no disease, and the milk had been sent to the Company as usual.

Medical Control in London.—In case of sickness among the Company's employés or their families in London, the patient is at once visited by the Company's Medical Officer, and if the sickness is of contagious character, the employé is suspended from duty, although his wages are paid in full during his absence.

Special Supply to Infected Houses.—Another feature which was introduced by the Company many years ago, and which is still peculiar to its business, is the system of supply to the houses of customers in which infectious disease exists. These are served by special messengers, thereby affording protection to the Company's other customers served by the ordinary delivery, and the cans used in such special service are specially cleansed and disinfected apart from those used in the ordinary deliveries. As it has no compulsory powers, the Company particularly request its customers to notify cases of infectious sickness in their houses, in order that this regulation may be rigidly carried out.

Analytical Control.—In addition to the Medical and Veterinary supervision above described, the Company has organized a most complete system of analytical check, to prevent any adulteration of the milk from the time of its receipt by the Company to the time of its delivery into the customers' houses. Samples are taken from the milk received, and sent out from the depot, and surprise samples are also taken during delivery. Some 35,000 samples were examined in the Company's laboratory during the past year. The system of control also includes bacteriological examinations, especially of the milk preparations for the use of infants and invalids.

Preservatives.—The Company's representatives gave evidence before the Departmental Committee on Preservatives and Colouring Matters that the Company did not use any preservatives in its milk or cream, and further experience has shown that there is not the slightest difficulty in supplying milk and cream in London without the use of preservatives of any kind.

Not a Paper System.—That the system of sanitary control which has been devised by the Company is no mere paper system, but one actually in force, may be proved by the documents and reports, furnished by the Medical, Analytical, and Veterinary Officers, which the Company will have much pleasure in showing to anyone interested. Reports of yesterday, last year, or twenty years ago can be seen, also the contracts, the analyses of the water, and the documents telling how every case of infection or suspected infection has been dealt with.

THE WHITE ROSE DAIRY FARM, YORK

The task which Mr. C. W. Sörensen, of the White Rose Dairy, New Earswick, York, has set himself is to obtain a naturally pure milk supply without modification or sterilization, and this he seems to have been most successful in accomplishing. The general lines adopted by Mr. Sörensen are those of the Copenhagen Milk Supply Company, with which he became thoroughly familiar in his native country. Mr. Sörensen's methods are of peculiar interest, because nothing is done by him that could not be accomplished by every dairy farmer in Britain. His whole aim is to supply a pure clean milk from healthy cows which are kept under hygienic conditions.

The byres are well lighted and ventilated, and the cubic capacity per cow works out at a good deal over 800 c. ft. There is an abundant supply of pure water, and cleanliness is most rigidly enforced. About 50 cows are generally kept, and among the number there are always some of the Alderney breed, which ensures that the richness of the milk will be maintained. The cows are clinically inspected once a month by the York Corporation Veterinary Officer, who is empowered to order the removal of any animal that is suspected by him to be unhealthy.

The feeding of the cows is also most carefully attended to. No turnip-tops or brewers' grains enter into their dietary. A high-pressure boiler for sterilizing all utensils, cans, &c., with steam has been fitted in.

Milking is carried out by a Lawrence-Kennedy milking machine with Thule cups. I was informed by Mr. Sörensen

that since the introduction of the Thule cups he has been quite satisfied with the machine, which seems to give very good results. All milk, immediately after milking, is passed through a Ulax Milk Strainer, and then rapidly cooled to a temperature at which the multiplication of micro-organisms ceases. Such milk will remain perfectly sweet and good for several days, even in the heat of summer, without the addition of preservatives or having been pasteurized. The milk is finally put into clean sterilized bottles, which are sealed at the dairy and delivered to the customers direct. It may be mentioned that the keeping qualities of the milk are so good that many customers are supplied every second day instead of every day.

The White Rose Dairy Farm is a model of what a dairy farm ought to be, and dairy farmers would do well to study Mr. Sörensen's methods.

Before concluding this section it may be useful to give a resumé of the regulations with regard to milk supply in New York, and a short description of American "Certified Milk".

REGULATIONS WITH REGARD TO MILK SUPPLY IN NEW YORK CITY

The following is taken from a report by Dr. Eastwood to the Local Government Board, on American Methods for the Control and Improvement of the Milk Supply.

The working of the New York system hinges on the regulation that "no milk shall be received, held, kept, offered for sale, or delivered in the City of New York without a permit from the Board of Health, and subject to the conditions thereof". When an application for a permit is made, a copy of these conditions is given to the applicant, and his premises are examined by an inspector. If the character of the premises is such that a permit cannot be recommended, the inspector informs the applicant of the defects which must be remedied, and after a reasonable length of time makes a reinspection. If the conditions are still found to be unsanitary, the inspector reports on the facts and recommends that the application for a permit be denied. Where the conditions are found to be suitable for the proper care and handling of milk, the dealer is recommended for a permit, and this is granted by the Board of Health.

From the "Rules and Regulations for the Care and Storage of Milk" I select the following for quotation:—"Milk must not be transferred from cans to bottles or other vessels on streets or on ferries, or at depôts, except when transferred to vessel of purchaser at time of delivery. . . . The vessels in which milk is kept for sale must be protected by means of a suitable covered receptacle, and so placed in the store as to prevent dust from the street or other impurities falling into it."

Section 53 of the Code prohibits the introduction into the city, or the offering for sale within the city, of any milk which is "adulterated"; and for the purpose of this Code milk is regarded as "adulterated" if it falls under one or more of nine specified definitions. From these definitions I select the following:—(*a*) "Milk drawn from animals fed on distillery waste, or any substance in a state of fermentation or putrefaction, or on any unwholesome food"; (*b*) "milk drawn from cows kept in a crowded or unhealthy condition"; (*c*) "milk the temperature of which is higher than 50° F."

Section 54 ordains that "any milk found to be adulterated which has been brought into the City of New York, or is held or offered for sale in said city, may be seized and destroyed by any inspector, or other officer of this Department authorized to inspect milk".

Every applicant for a permit to sell milk either in a shop or from a wagon must inform the Department of the source from which he obtains this milk. This information is followed up by the Department; the sources supplying the place from which the retailer obtains his milk are ascertained, and these are traced back to the actual producers. This is a task of considerable magnitude, since the milk supply of the city is obtained from a very large area, including parts of five different States, and some of it comes from a distance of 400 miles.

The control exercised by the city over milk produced in areas outside its limits is based on the following rule of the Department of Health:—"As a condition to the issuance of permits for the sale of milk in the City of New York, all places where such milk is produced or handled must be open to inspection by employees of the Department of Health of the City of New York." These inspectors have no authority to compel occupiers of places outside the geographical limits of the city to submit to inspection, but the threat that refusal will be followed by exclusion of the milk from the city is found to be effective. When the inspectors find the sanitary conditions unsatisfactory, the owner is informed that reform is necessary if he wishes to continue to supply New York City with milk.

Special arrangements have been made to ensure the early notification of infectious disease in any person handling milk. The following regulations affecting the dairy farms and the creameries, or collecting stations which receive and collect milk from individual farms and

transfer it to the railway, may be quoted:—"Every creamery or milk station which ships milk or cream, or both, to the City of New York, shall be required, through its agents, to furnish to the Department of Health of the said city, on Monday of each week, a report stating the existence or non-existence of any one of the following infectious diseases in the households of all persons employed in the collecting or handling of milk, either at the creamery, or at the farms or dairies supplying it; namely, typhoid fever, tuberculosis, diphtheria, scarlet fever, dysentery, or any other infectious disease. . . . Every creamery or milk station shall require each dairyman or farmer sending milk or cream or both to such creamery or milk station to report in writing on Saturday of each week as to the existence or non-existence of any one of the above-mentioned infectious diseases in the household of every employee in his farm or dairy, who is connected in any way with the care or handling of milk. . . . These weekly reports shall be kept on file at each creamery or milk station for a period of at least six months after their receipt, and shall be always open to the inspection of the representatives of the Department of Health." Then follow rules for the prompt exclusion of all persons suffering from infectious disease, the final regulation being that "the failure of any creamery or milk station, farm or dairy, to comply with provisions of these resolutions, may be considered sufficient cause for the exclusion of such milk or cream from the City of New York".

American "Certified Milk".—In many parts of the United States of America what is known as "certified milk" is obtainable. The production of such milk is carefully supervised by a medical milk commission, the members of which are chosen by a medical society in the city to be supplied. It is the duty of the commission "to endeavour to bring to the city a supply of milk produced under such regulations that purity shall be assured". Trustworthy dairymen are induced by reason of promised medical support and the increased price of their milk to conduct their dairies and collect and handle their milk in conformity with the requirements of the aforesaid medical commission and imposed by it in due legal form.

The commission, in the first place, establishes correct clinical standards of purity for cows' milk, carry out periodical inspection of the dairy or dairies under its patronage, and provide for bimonthly expert examination of the dairy

stock by competent veterinarians, and for medical supervision of the employees.

The milk is also subjected to periodical chemical and bacteriological examination under the direction of the commissioners. The expense of examination and inspection is defrayed by the dairyman, but the members of the commission receive no fee for their services. The findings of the committee are issued to the profession only, and the milk thus produced is known as "certified milk", and is sold in quart containers bearing the date of milking and the seal of the commission.

Such certified milk is, of course, sold at a higher price than ordinary milk, and is generally bought by people in better circumstances. The establishment of such supplies in many different parts of America has, however, had a very marked educative value on the people as a whole, as showing what can be accomplished in the direction of supplying a pure and wholesome milk.

CHAPTER IV

Final Methods of Treating Milk—Dairy Inspection, &c.

Sterilization — Pasteurization — The Budde Process — Artificially Soured Milk—Dairy Inspection—American Score Card System—Bacteriological Investigation of Milk—Milk Standards—Effect of Improved Methods of Dairying on the Price of Milk.

If the previously-discussed methods for improving the quality of milk were carefully and conscientiously carried out, we should obtain what we desire—a pure and clean milk free from disease-producing germs; and it is only by such methods that a thoroughly satisfactory milk can be obtained. When, however, it is remembered that, in many instances, but little attention is paid to such matters by dairymen and others employed in the milk trade; that bovine tuberculosis, so prevalent among milch cows, is difficult to recognize, unless by means of the tuberculin test applied by experienced persons; and how easily some of the commoner infectious diseases among dairy employees—unless the latter are subjected to systematic medical inspection—may be overlooked; it becomes evident that we must depend upon other methods of treating milk if we wish to be assured of its safety.

Some years ago it was thought that the solution of this problem lay in destroying the organisms by heat, and the sterilization of milk became fashionable.

Sterilization.—This term, as generally employed, means that the milk has been boiled. Such treatment is not suffi-

cient to sterilize milk in the true sense of the word, because that substance, as a rule, contains not merely germs but their spores, which cannot be destroyed by boiling.

In order to sterilize milk it would be necessary to raise it to a higher temperature than that of boiling water by heating it in sealed chambers under steam pressure. This, however, is seldom done under ordinary circumstances, and so-called sterilized milk refers to milk that has simply been boiled, and it is in that sense that we shall continue to use it.

Boiled or sterilized milk is incapable of disseminating infectious disease, but the boiling produces changes in the chemical composition of the milk, giving it a "boiled taste". Such milk has been known to give rise to scurvy in infants fed exclusively upon it; and experiments have shown that, though it is capable of digestion by persons in good health, for weak stomachs it is a less satisfactory food than raw milk.

Pasteurization of Milk.—The rationale of this process is to heat the milk to a temperature sufficient to kill harmful microbes, but insufficient to produce any radical chemical changes in the milk.

The manner of carrying it out varies. Sometimes a low temperature—say 140° F.—is maintained for an hour or more, or a higher temperature may be used for a shorter time—perhaps 160° F. for fifteen minutes—and so on. Needless to say, the effect produced will vary according to the method adopted. Much depends upon the temperature, and the length of time that the milk is exposed to it. As a general rule it is better to use lower temperatures for a longer time than higher ones for a shorter period. Jensen and Plattner state that the temperature should not be higher than 140° F., and that if the milk be maintained at that temperature for two hours all disease-producing germs will be destroyed, while very little change in the milk will be produced. Under ordinary circumstances it would be impossible to give milk such a prolonged exposure. A temperature of 158°–160° F., maintained

for half an hour, will kill most harmful organisms which milk may contain.

Many large dairy companies, having found it difficult to provide milk that will keep without the addition of preservatives, have adopted pasteurization, not with the idea of protecting the public, but to keep the milk from souring. Under such circumstances the milk is brought to the required temperature for an instant only—just long enough to reduce the number of lactic-acid organisms and thus increase its keeping quality, but not long enough to have much influence upon harmful bacteria. Pasteurization carried out in this fashion is of very questionable advantage to the consumer.

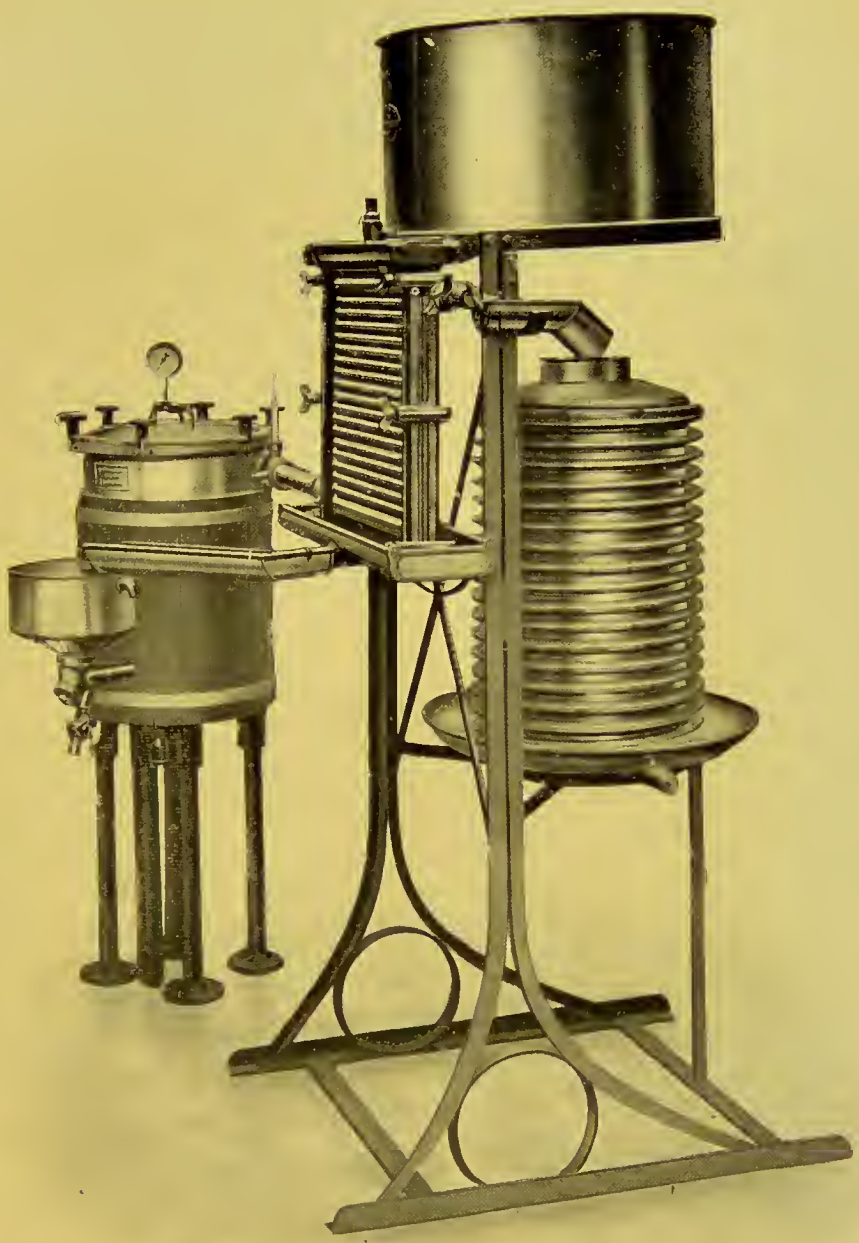
A scum must not be allowed to form on the top of the milk during heating, otherwise the process will not be efficient.

Pasteurizing Machines.—There is much variety in the style and construction of these machines. They may, however, be broadly divided into two classes, depending upon the principle on which they act—discontinuous pasteurizers and continuous pasteurizers.

Discontinuous Pasteurizers.—These machines possess a large receptacle in which the milk is placed and heated by a surrounding coil of steam pipes. During heating the milk is agitated by a mechanical stirrer, which prevents a scum from forming on its surface. Once the desired temperature is reached it may be maintained for any length of time, after which the milk is cooled by running cold water through the coil of pipes, or by some other means. It is then removed, and another portion of milk takes its place.

Continuous Pasteurizers.—In these the milk is made to flow in a continuous stream through a series of conduits in which it is heated to the desired temperature. It is then passed through another series in which it is cooled, and finally emerges in a continuous stream of chilled pasteurized milk.

Milk may be efficiently pasteurized by either the discontinuous or continuous methods. The former, however, is more reliable. In the continuous method those in charge are very



COMPLETE PASTEURIZING PLANT

The milk is poured into the Milk-receiving Tank above. It then passes through a Filter and over the Regenerative Heater, and from there into the Pasteurizer. From the Pasteurizer it returns and passes through the Regenerative Heater from below upwards, and finally over the Milk Cooler. Thus the cold milk, flowing over the surface of the Regenerative Heater, is partially heated by the hot milk ascending through the Heater from the Pasteurizer, and in this way an economy of steam and cooling water is effected.

apt to allow the milk to flow too rapidly through the apparatus, and thus the time of exposure is often too short.

Effect of Pasteurization on the Chemical Composition and Digestibility of Milk.—Raw milk contains certain enzymes which assist its digestion. These delicate ferments seem to be easily destroyed by the action of heat. Pasteurization, therefore, has a distinct effect upon the digestibility of that fluid. True, the heat applied is not sufficient to produce the chemical changes which occur when milk is boiled, nor are the albuminoids coagulated to any great extent, yet it is questionable how far pasteurized milk can safely be substituted for the raw material in the feeding of infants. It is stated that its constant use has been known to give rise to rickets, and the results obtained in connection with infant milk depots where the milk has been pasteurized have not always been satisfactory.

There is another point in connection with the pasteurization of milk that must never be lost sight of, and that is, that by its means the comparatively harmless lactic-acid bacilli are killed. These lactic-acid organisms have, in ordinary milk, an inhibitive action on the growth of other bacteria, but in pasteurized milk, in which the lactic-acid organisms are lacking, no such inhibitive action occurs, and therefore putrefactive germs have free scope for their development. Thus, while raw milk turns sour if kept, pasteurized milk undergoes decomposition, in which state it becomes dangerous to health. Old pasteurized milk, therefore, is worse than sour milk. Milk that has been pasteurized should always be used as soon after pasteurization as possible.

Some persons object to the wholesale pasteurization of milk on the grounds that, as the process is seldom thoroughly carried out, it gives merely a sense of false security and nothing more. It would be very unfortunate if a process which is capable of ensuring a safe milk supply should be prohibited because it is not always conducted in a proper manner. An attempt to improve existing methods is a matter of much greater importance. The following excellent rules,

which were added to the Sanitary Code of New York City in 1908, may be taken as an example of what might be done in this direction:—

"1. Pasteurization of milk must be carried out under a permit therefor issued by the Board of Health, in addition to the usual permit for milk required by Sec. 56 of the Sanitary Code.

"2. The milk, after pasteurization, must be at once cooled and placed in sterilized containers, and the containers sealed.

"3. All pasteurized milk must be delivered to the consumer in sealed containers which are plainly labelled 'pasteurized'. The labels must also bear the date and hour when the pasteurization of the milk was completed, the degree of the heat employed, the length of time exposed to the heat, and the number of the pasteurization permit issued by the Board of Health.

"4. Pasteurized milk must be delivered to the consumer within twenty-four hours of the pasteurization.

"5. No milk shall be pasteurized a second time."

Budde Process.—This process has recently been introduced into this country from Denmark. The following is a brief description of the manner in which it is carried out. The milk is first passed through a heater, where it is raised to a temperature of 50° C. or 122° F., and from there through a centrifugal cleansing machine. It then goes into a vat provided with a mechanical stirrer, and surrounded by a water jacket, the temperature of which can be raised by the introduction of steam. Immediately before the milk enters the vat it is mixed with an exactly calculated amount of hydrogen peroxide. Before the introduction of the milk the vat is raised to 122° F., and this temperature is maintained during the next three hours, the stirrer being worked now and then in order to secure a homogeneous mixture. As soon as the milk enters, the air is pumped out of the vat, so that a vacuum is produced, and thus any gases developed in the milk escape the moment they are formed. After three hours, air is admitted into the vat through cotton wool, and the milk is

passed through sterile tubes into sterilized bottles with tight-fitting stoppers. Before bottling, the milk is tested to see if any hydrogen peroxide remains, and if a surplus of that substance be found, a little catalase solution (which may be prepared from nearly any vegetable substance) is added in order to decompose it.

Action of Hydrogen Peroxide on Micro-organisms.—Milk contains an enzyme called catalase, which, when the milk is heated, is capable of decomposing the hydrogen peroxide, giving rise to the liberation of nascent oxygen, which acts as an efficient germicide. When hydrogen peroxide, H_2O_2, is thus acted upon it parts with an atom of oxygen and becomes converted into water, H_2O. Budde claims that the quantity of hydrogen peroxide which the milk can decompose is just sufficient for its complete sterilization.

Artificially Soured Milk.—Metchnikoff, in a book on the *Prolongation of Life*, strongly advocates the use of lactic-acid organisms as a means of lengthening life by preventing fermentative changes going on in the intestine. As a result of his teachings on this subject artificially soured milk has, for the time being at least, come strongly into public favour.

There are a great many strains of lactic-acid bacilli. That found in the Bulgarian sour milk is the most powerful lactic-acid bacillus known, and many preparations of this organism, put up in convenient forms for the manufacture of sour milk, are now on the market. Several enterprising dairy companies, also, sell a sour milk of this description ready for immediate consumption. Such milk is generally prepared from pasteurized milk to which a culture of lactic-acid organisms is added.

Uses to which such Milk might be Applied.—As to whether artificially soured milk will or will not prolong life need not concern us here. It is claimed that it is very useful in the treatment of indigestion, and morbid conditions of the digestive organs generally, which are due to the presence of bacteria causing putrefaction, with the production of organic poisons, in the digestive tract.

The writer contributed a paper to the *Medical Officer* of 24th April, 1909, on the use of such milk in the treatment of typhoid fever and as a prophylactic against typhoid bacilli carriers, part of which may be quoted here.

"In most cases of typhoid fever the individual becomes quite free from typhoid bacilli within a comparatively short time after recovery. Recent research has, however, shown that in a small percentage of cases the germs may persist for months or even years. Persons who thus retain the specific organism become what are known as 'typhoid carriers'.

"Dr. Kayser, of Strasburg, reported a very interesting case of this nature in 1906. A woman, forty years of age, carried on business as a baker in Strasburg. Ten years previously she had suffered from an attack of typhoid fever. She become struck by the fact that many of her employees, soon after entering her service, were attacked by digestive troubles of rather a grave nature, while two of them contracted typhoid fever. This woman, with the exception of an enlargement of the liver, seemed in every way normal and in very good health. Bacteriological examination of her fæces proved, however, that she often excreted great numbers of typhoid bacilli. It was not surprising, therefore, that persons who were in the habit of taking their meals prepared by this woman at the baker's shop, and who used the same sanitary convenience as herself, should become infected with typhoid fever.

"Many cases of typhoid carriers have recently been described by Continental observers, and by Ledingham and others in this country, while the case of 'Typhoid Mary', a cook in New York City, who went from one situation to another, leaving a record of at least twenty-eight typhoid cases in the houses where she had served, must be familiar to all who are in any way interested in the subject.

"That such typhoid carriers are a grave menace to the public health none can question, and that they may not infrequently be the cause of so-called sporadic outbreaks of typhoid fever seems probable. The health authorities in this country seem fully alive to the importance of the part played by such persons in spreading the disease, but the difficulty of discovering them and of preventing them from doing further mischief once they are discovered is very great.

"Certain observers state that having examined 1782 cases of typhoid fever, about 3 per cent of them became typhoid carriers. Is there no form of treatment to which typhoid fever cases in isolation hospitals could be subjected, that, without being in any way prejudicial, might prevent or lessen the chances of their harbouring the bacilli and thus becoming a source of infection to others?

"At the present time, on the advice of Metchnikoff, the action of lactic-acid bacilli is being strongly lauded as preventing fermentative

changes going on in the intestine. Thus Metchnikoff believes that it is possible to modify 'the flora of our alimentary canal by acclimatizing to our intestine useful microbes'. He and other observers have shown that active lactic-acid bacteria, ingested along with a suitable medium for their multiplication, such as milk or other sugary substance, pass through the stomach and establish themselves in the large intestine, where, by their presence, they inhibit the growth of the bacillus *Coli communis* and other intestinal bacteria. Indeed, it is claimed that the introduction of suitable lactic-acid bacilli affords a certain method of naturally disinfecting the whole gastro-intestinal tract more effectively than by any known drug.

"While resident physician in Belvidere Hospital, Glasgow, I had the opportunity of testing the efficiency of ordinary buttermilk in the treatment of typhoid fever. Without entering into detail, it may be said that those cases that were fed on buttermilk, or in which buttermilk formed part of their diet, seemed to benefit very markedly from its use. Their illness was less acute than that of those on the ordinary milk diet, relapses were less frequent, that distension of the abdomen which is frequently such a distressing feature of the disease was, as a rule, absent or very slight, and in no case fed on buttermilk did perforation occur.

"The chief difficulty in the use of buttermilk is to obtain it of uniform quality, there being much difference in the strain of lactic-acid organisms which different samples may contain; besides which *streptococci* and other organisms, which it would be very undesirable to introduce, especially into a diseased intestine, may be present. The Bulgarian 'Yahourt' or 'Yoghourt' is milk soured by the most powerful lactic-acid-producing bacillus known, and as preparations of this bacillus are now on the English market, a sour milk of standard quality (made from pasteurized milk, free from all undesirable organisms) may be easily obtained.

"The introduction of lactic-acid organisms into the intestinal tract of typhoid fever patients has certainly a beneficial influence in the treatment of the disease, but may it not have a further sphere of usefulness? Were patients suffering from this disease systematically fed on a soured milk containing lactic-acid organisms of known quality, or fed during convalescence in this manner, might not the number of persons who retain the typhoid bacillus after convalescence be lessened or done away with? Research points very strongly to the fact that lactic-acid bacilli have the power of inhibiting the growth of the bacillus *Coli communis*. If this be true, their influence on the bacillus *typhosus*, which is a less resistent organism, will probably be even more marked.

"Buttermilk was used in Belvidere as a curative agent, and as such I am convinced of its value, but it would seem that the use of lactic-acid bacilli might have a further sphere of usefulness in diminishing or preventing the retention of the specific organism after convalescence of the patient."

There is also another disease in which artificially soured milk would be pre-eminently useful, and that is infantile diarrhœa. The writer has seen many cases of this very fatal disease yield to the use of buttermilk when all other remedies had failed. It was administered to the infants in ordinary feeding-bottles, and had the effect not merely of checking the diarrhœa but of improving the nutrition of the child in a very marked degree. If municipal depots, where milk is prepared for infant feeding, or private dairy companies, would turn their attention to the production of suitably soured milk, and if the public could be persuaded to adopt it, a very marked reduction in the infantile mortality of our large cities would result.

DAIRY INSPECTION

The inspection of dairies by public officials is becoming more and more common in Britain. It is obvious that anyone who undertakes such a duty must be thoroughly familiar with all matters relating to the production of wholesome milk. An attempt has been made in the foregoing sections to give the information required for the purpose.

Apart from structural considerations in connection with farm buildings, which will be treated of in another section, the following is a list of some of the more important points which should be enquired into and noted in making an inspection of a dairy.

1. General state of cleanliness of the byre and dairy.

2. Condition of the cows.—Are they kept clean? Do they appear healthy? Are the udders free from disease? What is the condition of the supramammary lymphatic glands? Are the teats in a healthy condition? Has the tuberculin test been applied? Are the cows kept indoors all the time, or are they given exercise in the open air? On what kind of food are they fed? The time of feeding in relation to milking should also be noted.

3. Condition of the byre.—Does the byre seem airy and

light? Is the dung frequently removed? Is the byre as a whole kept in a cleanly condition?

4. How is the dung disposed of?—Is it deposited near to the byre or removed to a considerable distance?

5. The milkers.—Are they healthy persons? Is there any possibility of their coming in contact with infectious disease in their homes or otherwise? Do they wear clean overalls? Are they careful to wash their hands before commencing milking and after milking each cow?

6. Method of milking.—Are the udders of the cows washed and left moist? Is the wet or dry method of milking adopted? Is the operation conducted in a cleanly fashion, so as to produce milk under the best conditions? Is the milk removed from the byre to the dairy immediately after milking?

7. Source of dairy water supply.—If this appears doubtful samples should be taken for analysis.

8. Method of cleansing and sterilizing the dairy utensils.

9. Treatment of milk after milking, straining, cooling, &c.

10. Manner of transporting milk.—In bottles, churns, cans, &c. If churns be used, are they sterilized before being returned to the farmer? Is the farmer's name stamped on the churns, and are they sealed during transit? The condition of the churns (battered or otherwise) should be noted, and also the nature of their lids, and whether they are provided with ventilation holes.

The American Score Card System.—Many American cities have adopted what is known as the score card system of inspection. When inspecting premises where milk is produced, handled, or sold, the inspector fills up a card containing a printed list of the details on which he is required to report. A certain number of marks are allotted for each detail—for some more than for others, according to their importance. When added together the total maximum score generally amounts to 100, or some other convenient number. The card also contains printed instructions for each detail as to the conditions for which full marks may be given, and the number of marks to be deducted if defects are present. Opposite each

item there is a space for "remarks", so that the inspector may put down his reasons for any deduction that he may make.

After completing the filling in of the card, the total number of marks given is added up, and this number compared with the maximum possible score gives a good indication of the conditions present. The score cards are filed at the Public Health Office and are ready for reference when occasion requires.

This system makes the inspectors do their work more thoroughly, affords a guide to the milk producer as to how his premises compare with those of others, and stimulates a healthy rivalry, which perhaps does more to make a farmer keep his cows and premises clean than any form of coercion would do. Further, the scores are very often published in the local papers, so that customers may see what milkmen stand highest and choose accordingly.

Bacteriological Investigation and Milk Standards.—Much useful information with regard to a milk supply may be obtained by bacteriological methods. Thus, culture plates may be made and the number of bacteria which the milk contains per cubic centimetre may be estimated, or films may be made and examined under the microscope. These methods are for the most part used for estimating the total number of organisms which the milk contains, rather than for differentiating the pathogenic from the non-pathogenic bacteria, the latter being much more difficult to accomplish.

"The bacteriological examination of milk gives us a clue to the cleanliness of the methods employed, the temperature, and the age of the milk. The health officer who has the advantage of bacteriological assistance, knows that the milk of dairies containing excessive numbers of bacteria is dirty, old, or warm. With a bacteriological count as a guide, it is comparatively easy to determine the cause of the trouble and to institute proper means to correct it. The enumeration of bacteria in milk is, therefore, one of the readiest and cheapest methods at the disposal of health officers to determine the

general sanitary quality of the market milk supply. The laboratory results serve not only as a guide to direct the efforts of the health officer, but confirm the conclusions arrived at from an inspection of the dairies and dairy farms" (Rosenau).

Delépine has shown that it is possible to estimate, very accurately, the amount of foreign matter or dirt contained in milk by centrifugalizing samples and measuring the diameter of the deposit formed in the closed hemispherical end of tubes of uniform diameter which were employed for the purpose.

Milk Standards.—Many standards to which good milk should conform have been suggested, and many American cities have attempted to establish fixed numerical bacteriological standards for ordinary market milk. Thus milk arriving in Chicago must not contain more than 1,000,000 bacteria per cubic centimetre from 1st May to 30th September, and not over 500,000 between 1st October and 30th April. New York has a bacterial standard of 1,000,000.

While the bacteriological examination of milk may afford much valuable information it is questionable whether in practice such hard-and-fast numerical standards can be enforced. Newman has suggested the following standards of purity for milk, which is on a much sounder basis:—"(*a*) The acidity of 100 c.c. of the sample plus 2 c.c. of a 0·1 per cent solution of phenol-phthalein should not require more than 25 c.c. of a deci-normal alkali to produce a permanent faint pink colour; (*b*) no excess of pus or blood cells; (*c*) no *B. coli*, *B. enteritidis sporogenes*, or *B. enteritidis* of Gartner in 1 c.c.; (*d*) the milk to be non-virulent."

Effect of Improved Methods of Dairying on the Price of Milk.—An argument that is frequently brought forward against any attempt to improve the public milk supply is that any such attempt will inevitably lead to an increase in the price of milk. This is unquestionably true; indeed the whole problem is one of price, and no amount of legislation will induce dairymen to adopt methods which they cannot

afford. The very small price paid to farmers at the present day for their milk is in no small measure responsible for the "milk forcing" methods resorted to by them, and even with such methods the average British dairy farmer makes but a precarious living from his trade. The working of a modern, well-equipped dairy is certainly more expensive than an old-fashioned insanitary one. If the public insists that its milk supply be safeguarded, and that the farmer be required to take all proper precautions in its production, then it is right that they should be prepared to pay a price that will make it profitable for the farmer to do so. And surely it is better to pay a little more and get a pure and wholesome milk than be content to consume a questionable article which may be the direct cause of tuberculosis and other infectious diseases.

PART III

The Housing of Animals

CHAPTER 1

The Construction of Byres, Cattle Sheds, and other Farm Buildings

The Beneficial Influence of Fresh Air—Different Types of Byre—Construction and Internal Arrangements—Building Material—The Roof—Inside Walls—Floor—Stalls—Manure Channel or Grip—Passages—Feeding Troughs—Ventilation—Model Regulations—Principles of Ventilation—Various Forms of Ventilators—Cowls—Findlay Ventilator—Barr's Complete System of Ventilation—Ventilation in Relation to the Temperature of the Byre—Lighting—Improving Existing Cowhouses—Faulty Arrangements of Buildings in connection with Dairy Farms—Importance of a good Water Supply—Dairies—Essentials of a good Milk Store—The Housing of Fat Stock, &c.

We have already said that if cows were kept in the open air summer and winter there would be much less tuberculosis among them. Many farmers are of opinion that it would be quite impossible to keep milch cows out-of-doors during the wintertime, but this is to a large extent merely a prejudice on their part. The author has proved by practical experience that even Jersey animals, which are supposed to be among the most delicate of the bovine race, not merely live, but thrive in the open air, even in the winter climate of Scotland, provided they get abundance of food to eat.

The cow, like most other animals, has a wonderful power of adapting itself to circumstances. Thus, if an animal always accustomed to live in the warm damp atmosphere of an ill-ventilated byre, be suddenly transferred to a comparatively cool, well-ventilated cowshed, or out into the open during the wintertime, the chances are that it will take cold, or some

other form of illness, much in the same way as a hothouse plant, suddenly exposed to the outside atmosphere, is little likely to survive the change. But if the cow be gradually acclimatized to the difference in temperature and surroundings, a very different result will follow, because, when the cold season sets in, it will put on a heavy winter coat, designed by nature to keep its body at a temperature compatible with health, and will thrive in the improved condition of its environment.

If open sheds were erected in the fields to protect the animals from rain and snow, which are much more trying to them than mere cold in the shape of frost, it would be surprising how well they would thrive. But without going so far as to leave the cows outside during the wintertime—which would be an extreme measure—there is no reason why a perfectly healthy stock should not be reared in suitable byres and cattle sheds. It is imperative, however, that the standard of byres should be improved if tuberculosis is ever to be eliminated from our cattle.

Some farmers are very conservative, and strongly object to any change being suggested in the management of their cows. They maintain that anyone who desires cows to be housed in light, well-ventilated byres has no practical experience of the subject, and that their own method and that of their fathers before them cannot be improved on. One has merely to remember that it is estimated that from 25 to 30 per cent of all dairy cattle in Britain are tubercular, to realize what has been the result of such management. Clearly the farmer's method is not conducive to the health of the cows, and must be radically changed if a pure and wholesome milk is to be obtained.

Needless to say, there are many farmers and dairymen at the present day who are very anxious that their milk should be produced under the best possible conditions, and who spare neither trouble nor expense in accomplishing such an object. Great credit attaches to such men, and it is to be hoped that the public will appreciate the efforts thus made.

A byre should be designed in such a manner that the following essential requirements be attained:—

1. The cows housed in it should enjoy the best possible health.

2. Contamination of the milk should be reduced to a minimum.

3. Every facility for lessening the labour involved in feeding the animals and cleaning the byre ought to be afforded.

4. The cost of the byre should be as low as is consistent with good workmanship and efficiency, in order that the price of milk be not unduly increased.

We shall, in the first place, consider the erection of new buildings, and afterwards make some comments on the means by which existing byres of faulty construction may be improved.

Different Types of Byre.—Perhaps the commonest type of double byre is that in which the cows stand on both sides of a central passage with their heads close to the side wall of the byre (figs. 12, and 13, A). In such cases the central passage or gangway is used for conveying food to the cows, removing manure, and taking away the milk. This form of byre is cheaper to erect than any other, and, if properly constructed, may be very serviceable indeed. Its chief disadvantage is that, as the cows are boxed in with division blocks on either side of them and the wall in front, the air in the vicinity of their heads is apt to become stagnant and more polluted than in any other part of the building. This is, of course, undesirable, as the air which the cows breathe should be as pure as possible.

Byres for a single row of cows can also be constructed on this principle (fig. 14).

A second type of double byre is that in which a feeding passage runs down the centre and cleaning and milking passages or gangways at the sides (fig. 13, B). The cows stand in a double row facing the centre of the building, being separated the one row from the other by the feeding passage. Thus the breaths of the one row of cows come in contact with those of the other. This is a convenient type of byre to work,

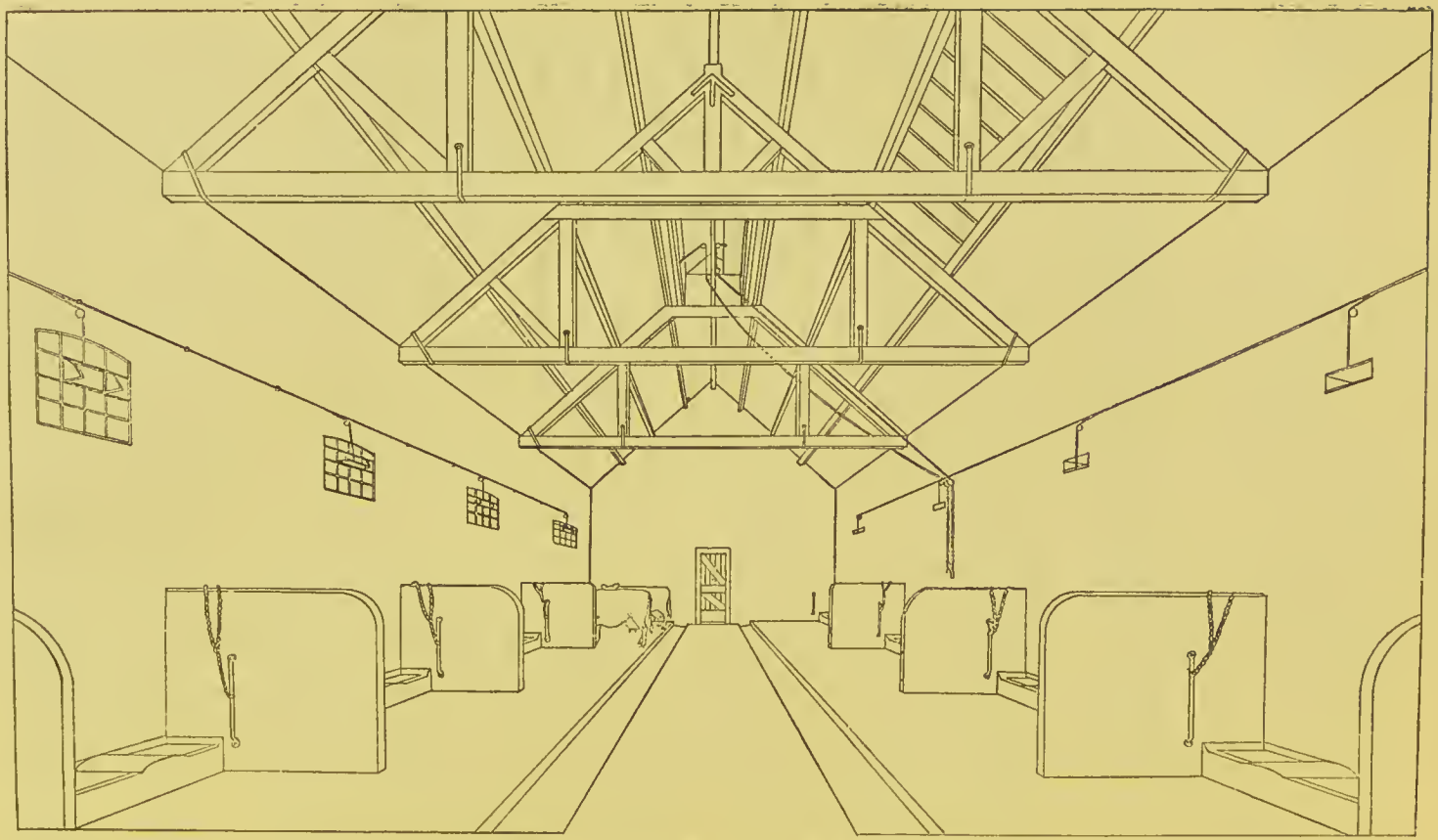


Fig. 12.—Interior of Cowhouse (From the Journal of the Board of Agriculture. By permission)

but one that is difficult to ventilate efficiently, because the heads of the cows are far removed from the fresh-air inlets on the side walls of the building. There is also the liability of a diseased animal infecting those on the other side of the feeding passage, and thus a building of this nature cannot be recommended from a health point of view.

In some districts a third type of byre is in use, which, though costly to build, has much to recommend it from various points of view. In it the cows stand facing the side walls of the byre, but with a feeding passage intervening between the wall and the heads of the cows (fig. 13, c). This feeding passage provides a free circulation of air about the animals' heads which is very beneficial. Down the centre of the byre runs the gangway.

Objections have been raised against this type of byre because the cows, when being fed, are apt to press forward toward the feeding passage, and, if the fittings permit, thrust their heads over the division. Should they defecate while in this

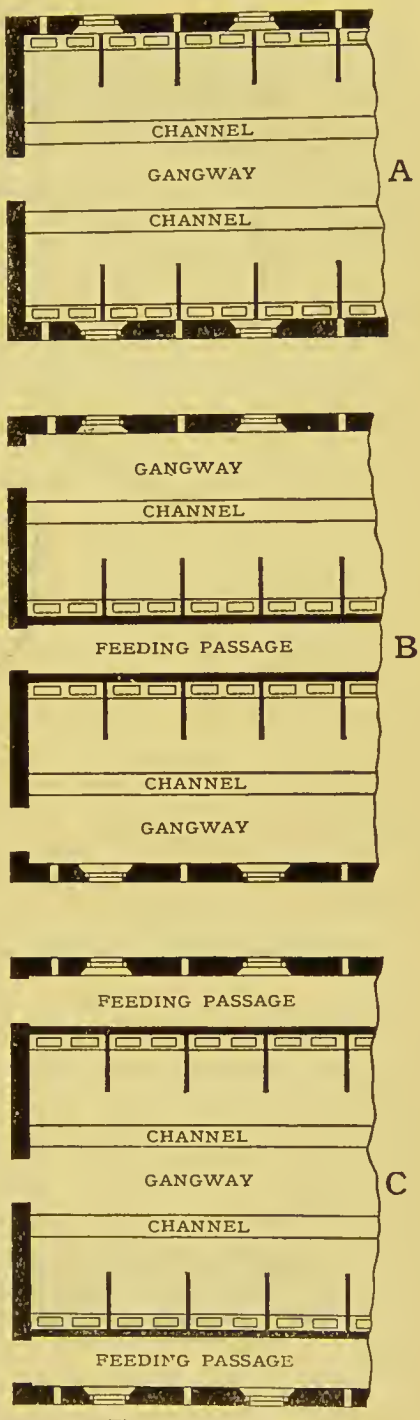


Fig. 13.—Types of Byre

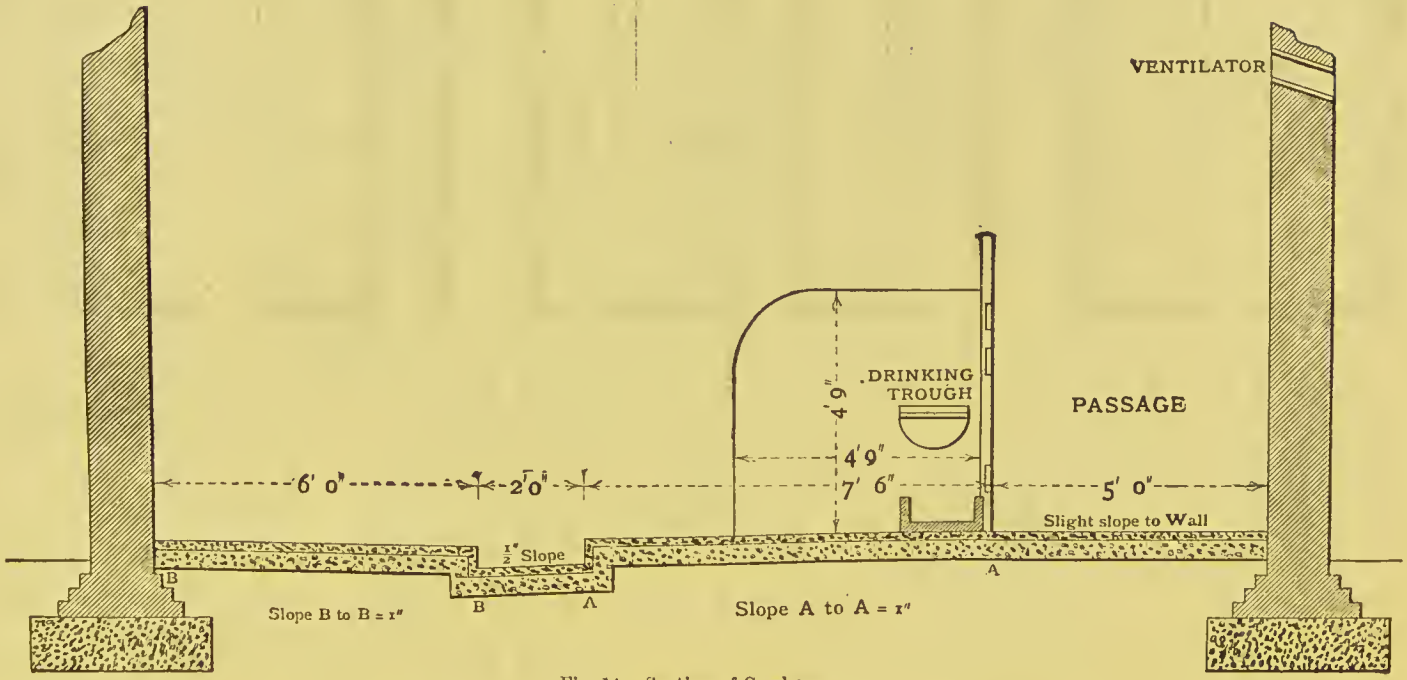
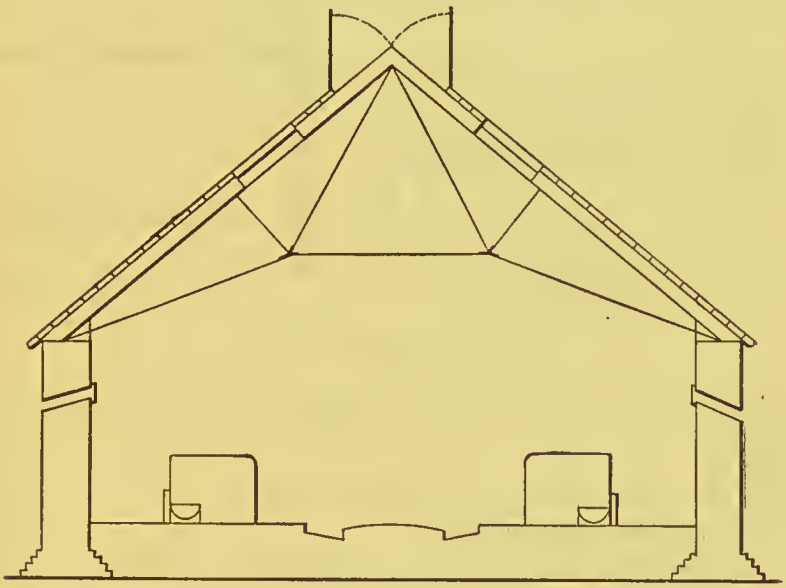


Fig. 14.—Section of Cowhouse

(Reproduced, by permission, from the Journal of the Board of Agriculture)

position, their dung falls, not into the manure channel as it ought to do, but on to the floor of the stall, where, if it be not at once cleared away, the cow may lie down on it, with the result that her hind quarters or udder become soiled. Now as our chief aim is to produce pure and clean milk, and as such cannot be obtained from a dirty cow, it is obvious how undesirable such a state of matters would be. The diffi-



Scale $\frac{1}{12}$ inch to 1 foot

Fig. 15.—Section of Third Type of Byre (fig. 13, c), fitted with Findlay Ventilator

culty can, however, be overcome by sparring the partition at the head of the cows so that they are unable to press forward, and such an arrangement allows of a free interchange of air. Where a passage intervenes between the cows' heads and the wall it is possible to ventilate the building in a much more efficient manner than when they are stalled with their heads to the wall. The extra cost of building such a cowhouse is not very great, because, though the floor space is large, the walls need not be so high, in order to obtain a certain cubic space, as they would require to be in a building in which no passage is provided at the animals' heads.

Fig. 16 shows a type of cowhouse that might with advantage be more commonly employed. It is a shed completely open in front, so that the cows, while sheltered from rain or snow, enjoy many of the advantages of an open-air life. Provision is made so that the front may be closed up during very cold weather, though, if the site be sheltered, this should seldom be necessary. A feeding passage runs along in front of the cows, while the gangway is behind. A large number of

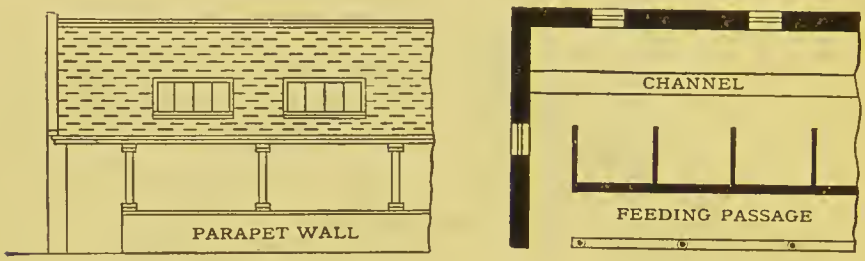


Fig. 16.—Open-shed Type of Cowhouse

windows are in the back wall, and the building is flooded with light.

It has been proved that cows housed in such a manner seldom contract tuberculosis.

Construction and Internal Arrangement. — While there is considerable variation in the type of byre that may be erected, there are certain broad principles connected with the construction and internal arrangements which must always be adhered to in the interests of hygiene and the health of the cow. These we shall now go on to consider.

Building Material.—Byres are, as a rule, built of stone or brick; wooden erections are sometimes employed, but are not very satisfactory, because hard non-absorbent internal surfaces are difficult to attain in this class of building.

Roof.—The roof may be covered with slates or tiles, but iron is not to be recommended, as it is apt to give rise to considerable fluctuations of internal temperature. A rather steep roof is preferable, because it facilitates ventilation. All byre roofs should be open to the ridge; a loft above a byre is always

objectionable. The supporting structures of the roof (tie-beams, struts, and king-posts), if made of iron, are easily kept clean. For a similar reason all woodwork in the interior of a byre should be planed, and, if possible, painted or varnished.

Inside Walls.—It is of little use recommending that the surface of the inside walls should, to a height of 6 ft. from the floor, be lined with white glazed bricks or enamelled tiles, because, however desirable, the expense of such a lining would be far too great for ordinary purposes.

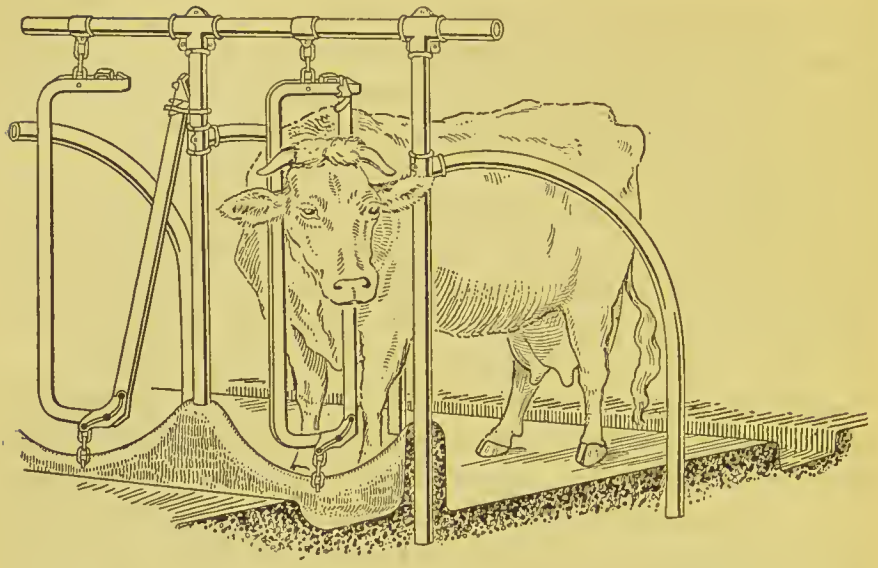
All inside walls should, however, be covered with cement, laid on with as smooth a surface as possible, for at least 6 ft. from the floor level. This admits of the lower part of the walls being washed as often as is necessary. Above the covering of cement ordinary plaster may be employed, but it is preferable if the cement be carried right up to the wall head.

The space between the top of the wall and the roof should be beam-filled to prevent the accumulation of dust.

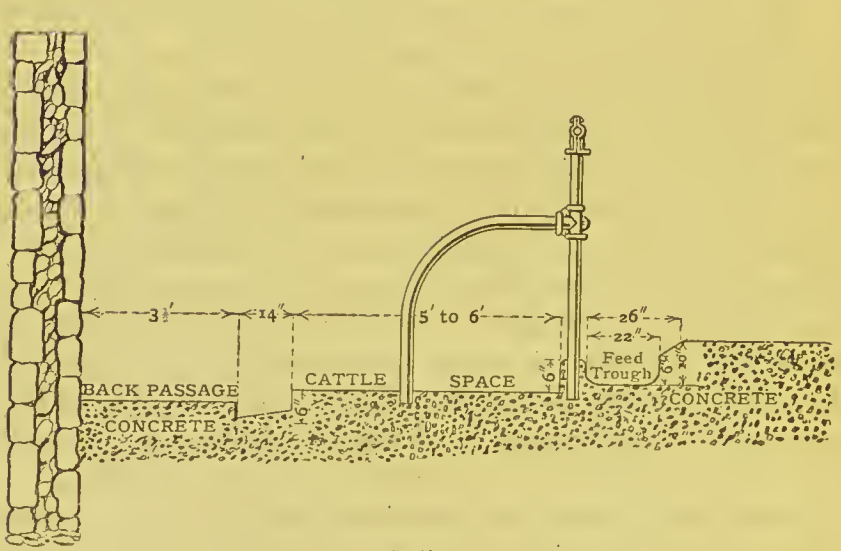
Floor.—The floor should be made of some hard impervious material, suitably sloped, so as to carry all urine and other waste water which may be spilled upon it into the grip.

The best material for the construction of floors is cement concrete, not laid too smoothly, otherwise the cows are apt to slip upon it. (While still soft it may be impressed by means of a roller with small squares or other pattern, which give the animals a foothold. A surface sufficiently rough to prevent the cows slipping, yet easily cleaned, may be obtained by taking an ordinary byre or stable brush over the concrete floor after it is laid, but before it has time to harden.)

Hard blue bricks are sometimes employed as a flooring material in the stalls, and along the gangway and feeding passage; if they are evenly laid and well grouted and bedded in cement, they are serviceable; but concrete is preferable, because it adapts itself more readily to the several gradients required for carrying off the wet. Red sandstone is sometimes used for the passages and stalls, but it is rather difficult to keep clean.



Cow in stall.



Section.

Fig. 17.—Method of Stalling adapted in certain parts of America

Stalls.—Cows are, as a rule, stalled in pairs, with a partition known as a division block intervening between each pair. These division blocks should be made of some hard, smooth impervious material, such as concrete covered with

cement, stone, slate slabs, or cast iron. Wooden division blocks cannot be recommended.

In some places the division blocks, instead of being solid, are made of iron railings. It is claimed for such division blocks that a freer circulation of air takes place in a byre where they are used. This is undoubtedly true; yet cows are apt to get their legs or horns caught in such structures, and thus give rise to trouble to themselves as well as annoyance to their neighbours.

In America, and many parts of Canada, cows are sometimes stalled in the manner shown in fig. 17. It will be noted that the fittings are made of rounded iron, which may readily be kept clean. There is also a freer circulation of air in byres in which such a method is employed, and it would seem that such fittings are worthy of the attention of interested parties in this country.

Mr. John Speir, in an article on "The Best Means of Housing Cows", says: "The stalls of all cowhouses should slope very gently from the trough to the edge of the manure channel, but in no case need the incline be greater than 1 in. in the whole length. For the smallest size of cows, such as Jerseys, Kerrys, and young Ayrshires, the stall should be from 6 ft. 10 in. to 7 ft. long, inclusive of the breadth of the trough. For Ayrshires a stall 7 ft. to 7 ft. 2 in. is quite sufficient, and for shorthorns 7 ft. 3 in. to 7 ft. 6 in. suits very well. In all cases the length of the stall should be proportionate to the size of the animal it is intended to accommodate, as the inconvenience arising from putting a large animal in a small stall is much the same as putting a small animal into a large stall. For Ayrshire cows each double stall should be from 6 to 6½ ft. in width, and for the larger breeds, such as shorthorns, 6½ to 7½ ft. wide."

The Manure Channel or Grip.—This is placed immediately behind the stalls, and should always be made of cement concrete. A brick channel is never satisfactory, as the large number of joints give accommodation for decomposing urine and manure. Mr. Speir says: "The manure

channel should be 24 in. wide and 6 in. deep at the side next the cows, and 4 in. at the passage. The floor of the channel should be ½ in. lower at the passage than at the cows' heels. It should also have a fall lengthwise of ½ in. for each cow (see fig. 14). These in themselves may seem trifling details, but they are of immense importance as far as the cleanliness of the animals is concerned. If the channel is made as suggested, it very seldom happens that the manure covers the whole floor of the channel; consequently when an animal voids any urine it at once runs to the low side of the channel next the passage, where it readily finds an outlet to the open air. If a narrower manure channel is adopted, the solid excrement covers the whole of the floor, damming back the urine, which stands in a pool between the lots of manure. When a cow lies down her tail drops in the urine, which later on she switches over her back, to the future detriment of the milk, the annoyance of the owner, and increased grooming from the attendant. Even where every precaution is adopted, extraneous matter will at times enter the milk; but if the manure channels are badly designed or paved the production of pure milk is wellnigh impossible, no matter what care is exercised."

"A similar result cannot be attained by deepening the channel and making it narrower. A *sine qua non* of an efficient cowhouse is a manure channel 24 in. wide, sloped as suggested, and nothing less will give satisfactory results."

In Mr. Sörensen's byres near York the manure channels are made to taper a little, so that the size of the stalls gradually increases to suit cows of different sizes. The result of fitting the stall exactly to the cow is that the manure channel is the only part of the stall that can be fouled. This is a matter of great importance to a dairyman, who may frequently be compelled to buy in fresh cows, perhaps of different breeds, in order to maintain his milk supply.

The manure channel should be continued through the end wall of the byre to the outside by a pipe with a smooth internal surface of sufficient diameter to admit of its being

readily cleaned. This pipe should discharge in the open air over an intercepting trap leading to a drain. The intercepting trap must on no account be placed within the byre.

Passages.—In most byres the passages are much too narrow. A feeding passage should never be less than 4 ft. wide, and may with advantage be broader. Milking passages in double cowhouses ought to be 6 to 7 ft. wide. It very seldom happens that each milker, when finished milking a cow, carries

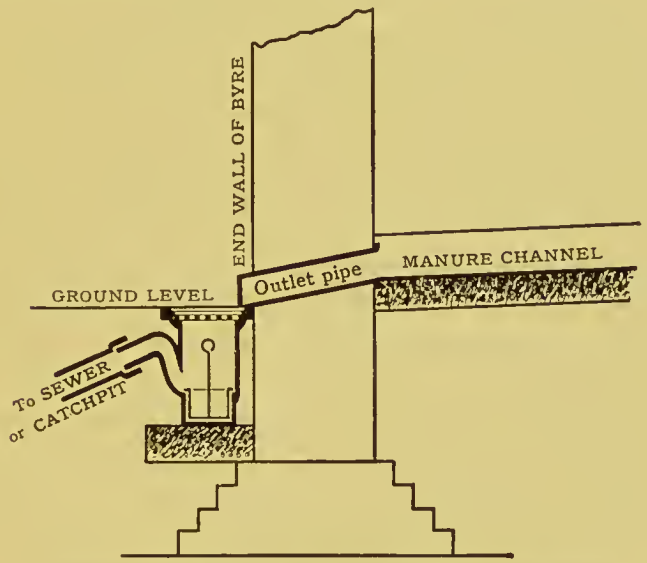


Fig. 18.—Method of Dealing with Sewage as it leaves the Byre

the milk direct to the dairy. Generally a special can is used for carrying the milk. This receptacle is left in the middle of the passage during milking, and the milk is emptied into it after each cow is finished. When full it is removed to the dairy and emptied, after which it is brought back to its place on the passage again. Such a habit cannot be too strongly condemned, as the milk standing in the passage is almost certain to become contamined by a cow in its vicinity passing either urine or dung. Each milker should carry the milk direct from the cow to the dairy; yet, as this is very seldom done in actual practice, a wide milking passage, 6 to 7 ft. wide,

is essential in order to minimize the above-described source of pollution as much as possible.

Feeding Troughs.—The feeding troughs, placed at the head of the stall, are generally made of glazed earthenware. Enamelled iron is also sometimes employed. Whatever the material used, all corners should be rounded off to facilitate cleansing.

The troughs should be placed about 1 ft. apart. Sometimes the intervening space is raised up and tapered to a point so as to keep fodder, &c., from accumulating upon it. For a similar reason the troughs should be set close to the wall and division block. Any intervening space ought to be filled up with cement having a long slope upwards.

Sometimes, instead of having single troughs, a long trough of glazed half-drain pipes is provided running the entire length of the shed. Such a trough may be used alternately for feeding and drinking purposes. When the animals are done eating the remains of the food are swept out. The water is then turned on and allowed to flow for a minute or two so as to wash away any particles that are left, and then the trough is allowed to fill with clean water for drinking purposes. Such a trough saves labour, is easily kept clean, but possesses one very serious defect, namely, that it may be the means of spreading disease. Should the nasal discharges of a diseased animal get into the water, and be conveyed thereby to a healthy animal, they may be consumed along with the water and set up the disease in the body of their new host.

Ventilation.—We now come to perhaps the most important consideration in connection with the construction of byres, namely, their ventilation. The more foul and close the atmosphere, other things being equal, the more surely and quickly will tuberculosis and other diseases spread among the animals breathing it. It is therefore of the utmost consequence that every byre should possess adequate means for its thorough ventilation.

Model Regulations.—The Model Regulations in connection

with this subject issued by the English and Scotch Local Government Boards are on similar lines; the latter, however, go into more detail than the former. Both recommend that a cubic space of not less than 800 c. ft. be provided for each cow, unless the cows are habitually grazed on grass land during the greater part of the year, or are turned out during the greater part of each day, when a lesser cubic space may suffice. The Scotch Regulations further recommend a floor space of not less than 50 sq. ft. per cow.

Both Regulations state that every cowshed shall be sufficiently ventilated by a sufficient number of openings into the external air to keep the air in the cowshed in a wholesome condition. The Scotch Regulations amplify this by stating that "The openings shall be so placed and constructed as to ensure a sufficient supply of fresh air to each animal, and such openings shall have an area of not less than 36 sq. in. for every 800 c. ft. of space in the cowshed".

It may be stated that very few existing cowhouses conform to the Model Regulations in respect to cubic space.

Principles of Ventilation.—The object of ventilation is to provide sufficient fresh air to keep the animals in health without causing a draught. It is possible that in the past too much attention has been devoted to cubic space and too little to efficient ventilation. Nevertheless, it is essential that a certain amount of cubic space be provided, if a free circulation of air without draughts is to be obtained. It should always be borne in mind, however, that large cubic space, though it assists ventilation, can never take the place of it. The atmosphere of even a very large byre, without ventilation, will soon become foul, and therefore it is only by frequently changing the air that good results can be obtained.

In natural ventilation we depend largely on the wind to bring about the required change of air. It follows, therefore, that the site of the byre—whether exposed or otherwise—will be an important factor in determining the best means of ventilation adapted to any particular case.

In all schemes of ventilation provision must be made, by means of inlet and outlet ventilators, for the admission of fresh and the exit of foul air. In a climate like that of Britain, where the weather conditions vary constantly, where one day a gale of wind may be blowing while on the next it may be quite calm, it is necessary that, whatever form of ventilators be used, they should be under control, so that on a very calm day they may be opened to their fullest extent, while on a cold, windy day they may be wholly or partially closed, or, again, that they may be closed on the stormy side and opened on the sheltered side according to circumstances.

Inlet Ventilators.—The most common form of inlet consists of an ordinary field tile or drain pipe built into the wall. Such openings are very often placed at the wall-head, so high up that the air must pass down, becoming contaminated in its descent before it reaches the cows. But the chief objection to them is, that the amount of air passing through them cannot be controlled in any way, and therefore it is no uncommon thing to find them completely blocked up with straw in the wintertime, just when the presence of the cows by day and night make it desirable that the byre should be properly ventilated.

A very simple and efficient form of inlet ventilator, which is completely under control, working on the same principle as the ventilators above the doors of railway carriages, may be constructed as follows:—Along the side wall of the byre a row of openings are provided, one for each cow or one between each pair of cows. These openings, made by means of ordinary field drain pipes built into the wall, should be of an area of 30–40 sq. in. per cow, and situated at a height of about 6 ft. from the floor. A board a few inches wider than the diameter of the tiles, and with holes cut in it corresponding in size and in interval to those of the tiles, is carried along the inside of the wall against these openings. This board works in grooves, so that by sliding it backwards and forwards the openings can be partially or

wholly closed at will. Mr. John Findlay fastens metal hoods over the holes on the inner side of the sliding board so as to direct the incoming air in a downward direction.

Another form of inlet ventilation is that in which the openings through the wall are placed exactly opposite that end of the division block which rests against the wall. An aperture is made in the division block close to the wall, opposite and at right angles to the opening from the outside, so that the fresh air on entering is distributed in a lateral direction. Such openings are generally placed at a height of about 2½ ft. from the floor, and should be guarded on the outside by a grating to prevent the entrance of vermin.

Nose Ventilation.—A system of inlet ventilation known as "nose ventilation" is sometimes resorted to. In this an opening passes through the wall but not directly, that part on the outside being at a different level from that on the inside, so that a direct through draught is impossible. Each opening on the inside is placed directly opposite the nose of the animal that it is intended to serve with fresh air, and is guarded by a louvred arrangement by means of which it may be opened or closed at will.

Other inlets are made by openings leading directly through the wall at a height about that of the animals' noses, guarded on the outside by an arrangement of louvres which causes the air passing through to be deflected in an upward direction, while on the inner side there is another louvred mechanism which directs the air downwards. Thus fresh air enters the byre without causing a draught.

If windows are placed on the side walls they may, in part or in whole, be made to open inwards, thus affording additional means of inlet ventilation.

Outlet Ventilators.—Outlet ventilators, whatever their form may be, are as a rule placed at or near the ridge of the roof. Louvred ventilators of many patterns are employed for this purpose. Thus, a continuous louvre may run along the ridge for the whole length of the byre; or

separate louvred ventilators may be placed at regular intervals. The chief objection to this form of ventilator is that it is apt to cause down draughts on the animals standing on the opposite side from that on which the wind is blowing, though much may be done by proper construction to overcome this defect.

Cowls.—Cowls are very often placed on the ridge of byres for the purpose of exhausting the vitiated air. They are of many different shapes, and exhibit a great diversity of construction. They work well as long as the wind blows

Fig. 19.—Louvred Ventilators

with considerable force, but on calm, still nights, when their action is most required, they are of little use.

Findlay Ventilator.—One of the best forms of outlet ventilator is that introduced by Mr. John Findlay (fig. 15). It is situated at the ridge of the roof. The roof, instead of being carried up to the ridge in the usual manner, stops short about a foot from it on either side, thus leaving an elongated open space, which runs along the centre of the roof from end to end. This space is occupied by a couple of long-shaped windows, hinged at their lower borders. These windows, when closed, continue upward the slope of the roof, meeting at the point where the ridge would ordinarily be, against one another. When opened, they rise toward the perpendicular, leaving an open space along the centre of the roof. The windows can be opened to any

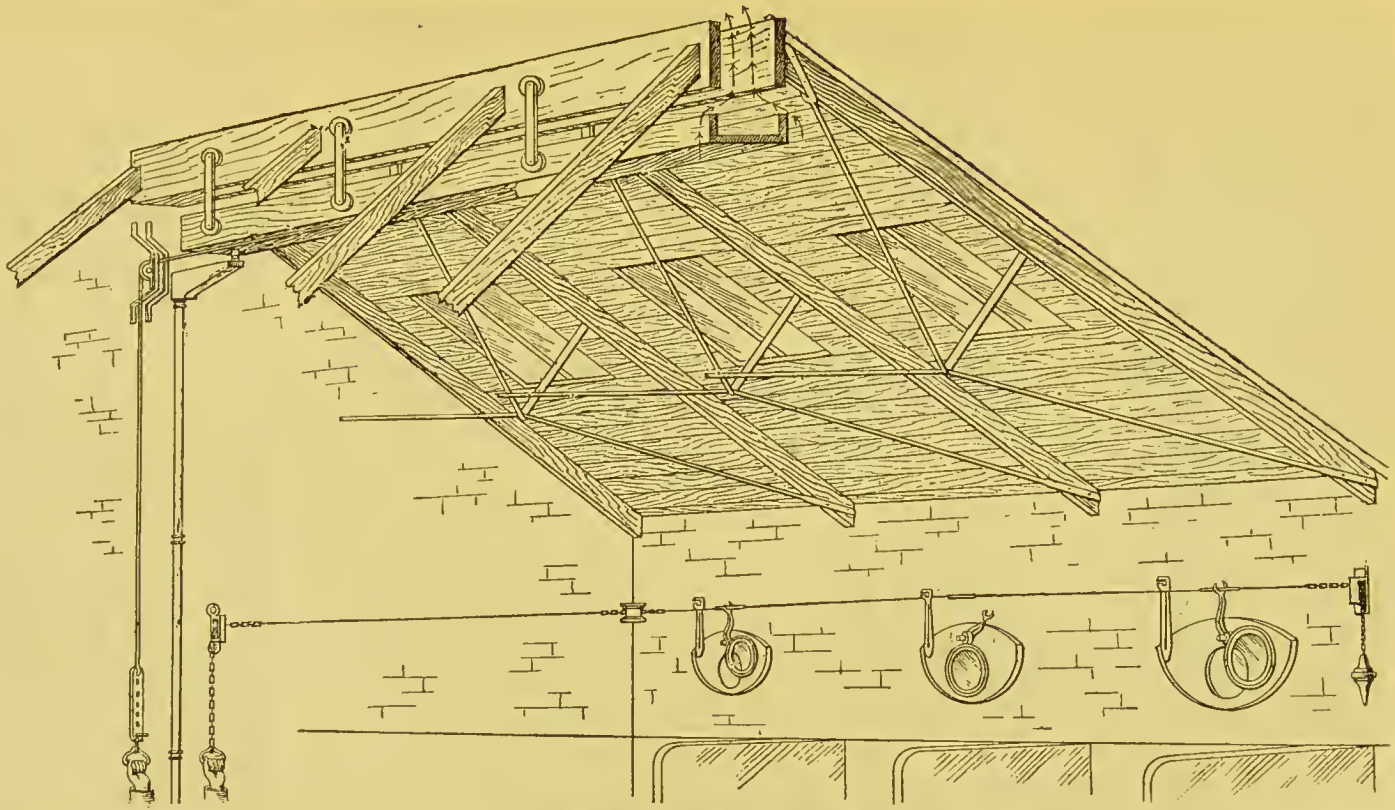


Fig. 20.—Barr's System of Ventilation

required degree by a mechanical arrangement controlled by a hand lever at the side of the byre door. Such a form of ridge ventilator acts not merely as an efficient ventilator, but also, by admitting light, serves to illuminate the interior. Thus it fulfils the double purpose of ventilator and window.

Barr's Complete System of Ventilation.—

Inlet Ventilation.—This is effected by building special

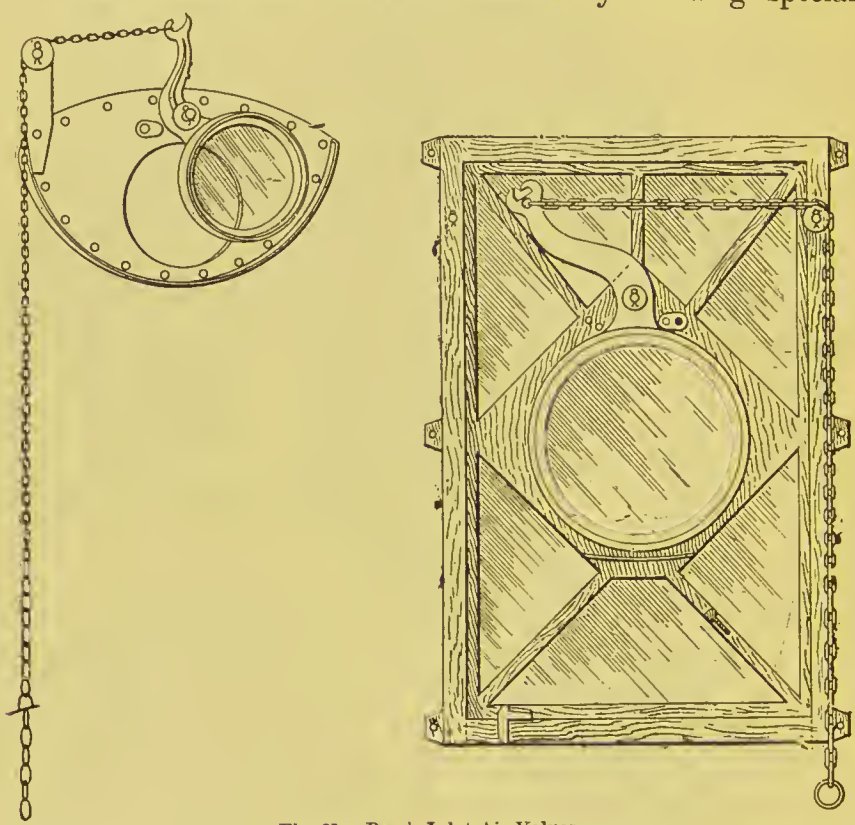


Fig. 21.—Barr's Inlet Air Valves

fireclay pipes into the wall. To the inner ends of these pipes adjustable air valves are attached. These are designed so that they may be worked singly or in groups. Fig. 20 shows the principle on which they act, it being possible to open them wholly or partially by pulling on the wire at the end of the byre, and fixing it so that it may maintain them as required. One or more valves may be disengaged from the wire and kept closed, without interfering with the

working of the others, by removing the link (attached to the wire) from the lever on the valve and inserting the wire in the support above—a very useful arrangement when cows are calving.

The valves are made either of solid metal, or with a glass panel for the purpose of admitting light. The latter combine light and ventilation.

If desired, a wrought-steel hood can be fitted on to the face of the valves so as to direct the pure air down the surface of the wall to the animals' heads.

Outlet Ventilation is provided for by an adjustable double ridge-board ventilator. There are two ridge boards, which may have any size of an open space between them, the whole length of the ridge having only a covering of netting wire to exclude birds. To prevent down draughts a light gutter is hung under the opening between the ridge boards in such a manner that when a wire rope, attached to its bottom and passed over a pulley at the end of the byre, is pulled, it swings upwards, thus closing the outlet wholly or partially as desired. The gutter, further, prevents the admission of rain or snow, which, falling into it, gravitate to a rain conductor placed at the end of the building.

By this arrangement the whole length of the ridge can be open or shut at will, and the temperature of the byre be raised or lowered in a few minutes (fig. 20).

Barr's system of ventilation is simple, efficient, and strong; it can be fitted with equally good results to byres or piggeries, and is well worthy of the attention of anyone interested in such matters.

Ventilation in Relation to the Temperature of the Byre.—It is generally supposed that cows kept in a warm atmosphere produce more milk than in a colder one, and as this warmth is, as a rule, derived from the bodies of the cows themselves, it is usual to find all the ventilators in a byre stuffed with straw in the wintertime so as to keep the interior at as high a temperature as possible. It is further stated that a well-ventilated byre is a cold byre, and that

for this reason it is impossible to adequately ventilate a byre in this country during the wintertime. In order to obviate this difficulty attempts have been made to artificially warm byres by means of hot-water pipes and other appliances. The result of such attempts have not, so far as we are aware, been satisfactory. The initial cost of such byres is great, and the subsequent cost of firing has frequently proved prohibitive. The atmosphere of an artificially warmed byre is apt, unless the temperature be very carefully regulated, to be even more close and offensive than an ordinary badly ventilated one, and possesses an ammoniacal odour that is almost overpowering.

Whilst it seems to be the almost universal opinion among farmers, that a warm byre increases the flow of milk, certain recently conducted experiments have not corroborated this view.

In the *Transactions of the Highland and Agricultural Society of Scotland*, 1909, will be found the results of a most interesting series of experiments conducted by John Speir, Esq., of Newton, on "Influence of Temperature on Milk Yield". Among the conclusions come to by him the following may be quoted:—

"There is no difficulty, much less impossibility, in producing milk in freely ventilated byres in the coldest weather likely to be met with in this country, if the cows are freely ventilated and kept sufficiently cool in early autumn."

"While the present experiment shows that rather more milk has been produced under conditions of free ventilation than where ventilation was restricted, it would be injudicious, till these results have been corroborated by other trials, to consider that this will invariably happen. It is unquestionable that the general health of the cows would be better under free than under restricted ventilation."

"Milk produced in a building kept at a high temperature, or during a warm period, does not seem to be any richer in fat than that produced at a low temperature or during cold weather."

"It seems hopeless to expect to be able to keep the air of

any byre, no matter how the byre may be constructed, at from 60° F. to 63° F. during the ordinary weather of an average winter without excessive pollution of the air."

"Any saving in food which is effected by keeping the animals at a higher temperature is equalled, if not excelled, by improved digestion when they have plenty of fresh air but a lower temperature."

"There is reason for believing that those great scourges of the dairyman, mammitis or weeds and tuberculosis, may be reduced to a minimum if cows are kept in freely ventilated byres in winter."

Again, Mr. Dunbar, as a result of a series of experiments conducted by him, comes to the conclusion "that practically the same variations occur in the flow and quality of milk during high and low temperature of byre and atmosphere".[1]

The Agricultural College in Shropshire, also, kept a herd of cows under open-air conditions and a similar herd of cows under warm-shed conditions. At the end of the first year, the results obtained were as good in the one herd as in the other. After four years' observation it was found that there was practically no difference between the two herds so far as the quality and quantity of the milk was concerned.

Lighting.—It is frequently stated that cows feed better in a dark place, and that therefore the fewer windows a byre possesses the better. This is merely a prejudice which has no foundation in fact. There is no reason why a cow should live in darkness, there are many reasons why it should be given abundance of light. Dark cowsheds favour, not merely the multiplication of the tubercle bacillus and other micro-organisms, but also the accumulation of dirt. If a dark byre be dirty and badly kept the neglect is not very noticeable, whereas in a well-lit byre, want of cleanliness is easily seen. Light is also essential for the health and wellbeing of the cow. All byres and cowsheds should therefore be provided with sufficient window space, so that the whole of their interior may be flooded with light.

[1] Seventeenth Annual Report of Sanitary Inspector of Dumbartonshire.

Model Regulations.—The English Regulations state that every cowshed shall be sufficiently lighted with windows, whether in the sides or roof thereof. The Scotch Regulations add that the total area of window space shall not be less than 3 sq. ft. for every 800 c. ft. of space in the cowshed.

Windows may be placed on the side and end walls and also on the roof. All windows should be made openable in part or in whole. The upper sashes of those on the side and end walls ought to be made to open inwards, and thus serve as ventilators on the principle of the Sheringham valve. Those on the roof should likewise be under control.

Wash-hand Basins, &c.—In connection with every byre there should be one or more wash-hand basins, either in the byre itself or in some other place, where the milkers may conveniently wash their hands. Clean towels on rollers ought also to be provided. Taps to which a hose may be attached for the purpose of flushing out the byre are very useful, and greatly facilitate the thorough cleansing of the premises.

Many byres in America are provided with overhead tracking (similar to that employed in slaughter-houses) to facilitate the feeding of cows and the removal of dung. This is a most useful arrangement, that might with advantage be introduced into this country.

IMPROVING EXISTING COWHOUSES

It is a matter of no great difficulty to build a new byre to meet modern requirements, but it is much more difficult to alter existing buildings in order to bring them up to date. Yet this is a problem of the greatest importance, because, while it is obviously impossible to build new byres all over the country, even unsatisfactory premises can often be much improved at a comparatively small cost.

With a knowledge of what a modern byre should be, it is generally comparatively easy to suggest alterations in existing buildings which may have a most beneficial result.

The floors of many country byres are very deficient.

Thus cobble paving, unevenly laid and without manure channels, is frequently met with. In other parts of the country the floors may be of chalk, rammed tight, or even of earth.

It is absolutely impossible to keep such floors clean, and an impervious floor of cement concrete, with properly formed manure channels, should always be substituted. Sometimes gully traps leading to drains are found within the byre. They should be removed to the outside of the byre, where the drainage may flow into them in the open air. Covered drains in the inside of the byre are also very objectionable. These should be replaced by open manure channels leading to apertures in the byre wall, through which the drainage may pass to a trapped gully on the outside of the building.

The cows ought to be chained or fastened so that they may dung and pass water into the channel, and not on the floor of the stall, in order that their hind-quarters and udders may be kept clean.

The ventilation and lighting of cowhouses is seldom adequate. Lofts are often situated above the byre, so that thorough ventilation is impossible. These should be removed, in order that the byre may be open right up to the ridge of the roof. If there are not sufficient openings in the walls, apertures may be made and fireclay pipes inserted to act as inlet ventilators. A ventilator of the Findlay type at the ridge will serve the double purpose of outlet and window.

The surface of the inside walls is often very rough and uneven. Such walls may sometimes be improved by a coating of cement either the whole way up or to a height of 6 ft. from the floor. Where the walls are of brick the application of "petrifying" liquid, obtainable at 10*s.* 6*d.* per gallon, has been recommended, and is said to give them a smooth and easily washed surface. Frequent limewashing of inside walls is very beneficial.

Many farm buildings are from 18 to 20 ft. wide. Such premises may be converted into single byres on the principle shown in fig. 14 at a comparatively moderate cost.

Faulty Arrangement of Buildings in connection with Dairy Farms.—The arrangement of buildings in connection with dairy farms, however convenient for working, is certainly in too many instances not sanitary. Thus it is no unusual thing to find the scullery, where the milk dishes are cleansed, in direct communication with the dwelling-house, and the milk store in direct communication with the scullery, so that should an unrecognized case of scarlet fever or other infectious disease be in the dwelling-house there is great likelihood of the milk becoming contaminated. Such faulty arrangements very often compel a medical officer of health to stop a milk supply coming from a farm where infectious disease exists. Were the byre and milk store completely isolated from the farmhouse, and were it possible for the milkers and those handling milk to live in cottages detached from the main dwelling, in many instances the supply of milk could be continued.

It is therefore a matter of very great importance that milk, and all things required in connection with it, should never come near the dwelling-house at all, but be kept altogether apart from it in premises isolated from all other buildings.

Water Supply.—It is essential that every dairy establishment should be provided with an abundant and wholesome water supply. Abundant, so that the byre may be every day flushed out (with a hose, if possible); and wholesome, so that the cows' health may be preserved, and the milk churns and other dairy utensils may not be contaminated.

Care should always be taken that cows get plenty of clean water to drink, as those animals are only too prone to drink polluted water whenever they get the chance, which cannot have a good effect on their health and may affect the quality of their milk.

The water supply of very many farms throughout the country is far from satisfactory, it often being obtained from wells in the courtyard, which are open to serious pollution, or from other undesirable sources. It is interesting to note

that more than half the farms desirous of supplying milk to the Aylesbury Dairy Company are rejected because their water supply is pollutted. This gives an idea of the existing state of matters, and clearly demonstrates the urgent need of reform.

DAIRIES

The size and equipment of the dairy depend on the work to be carried on therein. In farms where butter or cheese is made a large and commodious dairy is required. Such buildings should be isolated, and should comprise:

1. A Milk Store, where the milk is retained until required.

2. A Work Room, in which the separation of milk, the churning and making up of butter, or cheese making is carried on.

3. A Scullery provided with a boiler, where all dairy utensils may be washed and sterilized.

4. A Store Room for the ripening of cheese.

Milk Store.—When a farmer sells sweet milk and sends it off morning and evening, a dairy of much simpler design is all that is necessary. Such a milk store should stand by itself, having no internal communication with the cowshed or dwelling-house.

It is essential that it should be dry, clean, cool, well ventilated, and free from atmospheric impurities. For the sake of convenience it should be situated near the byre, but great care ought to be taken that it is not exposed to effluvia from the cowshed, stables, or dung-heap, as a bad odour may taint the milk.

Construction.—The walls should be thick, or else hollow, so that the internal temperature may be as equable as possible. All internal surfaces must be hard, smooth, and non-absorbent, and all corners rounded off, so as, as far as possible, to prevent the accumulation of dust, and to permit of the whole being easily cleaned.

The inside walls may be, for a distance of some 6 ft. from the floor, lined with white enamelled bricks or tiles,

which present a very clean and tidy appearance, but cement laid on with the smoothest possible surface is cheaper, and answers the purpose very well. The floor should be of concrete, and the ceiling of varnished wood. The shelves on which the milk stands may be made of stone slabs, slate, or concrete. Two iron girders running parallel side by side are sometimes used to support the milk dishes in place of a shelf. Occasionally, where concrete is employed, the shelves are moulded into shallow troughs with a gentle slope from one end to the other, so that when water is turned on at one end it flows slowly to the other, where it makes its escape, coming in contact with the exterior of the milk pans and cooling the milk as it goes.

The window or windows should, if possible, face north for the sake of coolness, and ought to be protected on the outside by perforated sheet zinc in order to prevent the entrance of flies and other insects when the window is open.

Scullery.—The scullery, where milk dishes are washed and scalded, should be kept exclusively for this purpose, and on no account should domestic washings be done under the same roof.

The boiler must of course be kept for the scalding of milk dishes only, and be used for no other purpose.

The boiler-house ought not to have any internal communication with the dwelling-house, but may with advantage be situated in connection with or near to the milk store. If it can be provided with steam-jets for the sterilization of milk churns so much the better.

HOUSING OF FAT STOCK

In farms where mixed farming is carried on, animals that are to be fattened are often kept in the byre along with the milch cows, and fed on hay, oilcake, and other materials until they are ready for the butcher. In other parts of the country where many animals are fattened the farms are often provided with open yards—a yard in the centre with roofed sheds all

round it. The animals may shelter in the sheds when the weather is bad, and move about the yard as they please at other times. Dung is often allowed to accumulate in such yards for long periods without being cleared away; indeed, the housing of cattle in this manner is looked upon by farmers as one of the best methods of "making dung", and it is no unusual sight to see animals sink pretty deeply into it as they go from one side of the yard to the other. Needless to say, such a state of matters is prejudicial to the health of the animals.

Store cattle (animals that are being fattened) are sometimes also put into loose-boxes, or other forms of sheds and byres.

CHAPTER II

The Housing of Swine, and the Law relating thereto

The housing and management of pigs is a matter which does not in this country receive the attention that it deserves. The high mortality among those animals is sufficient proof that existing conditions are far from satisfactory. It is generally supposed that pigs are naturally dirty animals, and that the more filthy their surroundings the better they will thrive. This is an entire mistake, for there is perhaps no class of stock that will derive more benefit from comfortable and cleanly housing, and will yield better profits for the care and trouble expended on them.

Properly constructed pig-houses are easily kept clean, and the animals living in them are much healthier, and less liable to such ailments as rheumatism and chills, than those kept under less favourable conditions. Moreover, the risk of swine fever, a disease which is principally perpetuated in dirty and badly designed sties, is thereby much lessened. Thus the labour and expense of building a good sty and keeping it properly are very soon repaid.

Again, a very large number of pigs are found, when brought to the slaughter-house and killed, to be affected with tuberculosis. This disease is probably chiefly derived from feeding those animals on tubercular milk, but bad conditions of housing will also do much to foster and perpetuate it.

The size and design of pig-houses will vary considerably, according to circumstances; thus, where only a limited number of pigs is kept the sties are generally of simple design, whereas

where pig-keeping is practised as an industry, large and more elaborate piggeries are required.

General Principles.—In the construction of any type of pig-house, what should be aimed at is to provide a rainproof structure, which can be freely ventilated and kept at a more or less equable temperature throughout the year. Provision must also be made for good lighting, and an efficient method of drainage.

Cubic Space.—Where no open yard adjoins the sty an air space of about 150 to 200 c. ft. per pig is required.

Ventilation.—Efficient ventilation is even more important than air space, because, no matter how great the latter may be, the air will eventually become foul unless frequently renewed. Ventilation is secured by means of inlet openings in the walls and outlet openings in the roof, which may be regulated by one of the methods already described in connection with byres.

Materials for Construction.—The walls may be made of brick, stone, or concrete, rendered smooth on the inside with cement mortar. The roof should be covered with wood on the inside, and slates or tiles on the outside. Corrugated iron may also be used, but is not to be recommended on account of the fluctuations of internal temperature to which it gives rise. The floor ought to be laid with concrete, and have a gentle slope from the back to the front of the sty to facilitate drainage. Some recommend that a portion of the floor of each sty should be laid with asphalt or wood, as these substances form a much warmer surface for the pigs to lie down on, and thus tend to prevent rheumatism. No great objection can be taken to asphalt, which should be laid 1 in. thick on top of concrete. Wood, however, should never be employed, and is indeed quite unnecessary, because a low platform of wood laid on the concrete floor serves the purpose equally well, and possesses the great advantage that it can be periodically removed and cleaned.

A breeding sty should be provided with a "guard" running round the wall to prevent the sow from crushing her young

against the wall when lying down. It is recommended that this should be made of iron tubing $1\frac{1}{2}$ in. in diameter, supported on uprights of the same material, let 2 in. into the floor, and extending 10 in. above the floor level.

Designs.—Where only one or two pigs are kept the houses in which they live are generally of simple design, being as a rule divided into two parts, an open yard surrounded by walls in front and a roofed sty behind (see fig. 22). The trough, made of glazed earthenware or iron, should be placed right at the front of the yard on the left-hand side. Just over the trough

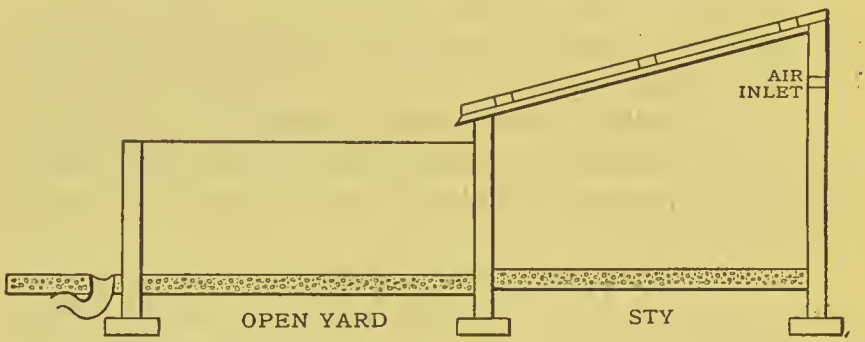


Fig. 22.—Ordinary Type of Pig Sty

there should be an aperture in the wall fitted with a falling door made of iron, which, when pushed inwards, allows of the pig's food being poured straight into the trough, without the feeder requiring to enter the yard. There should always be a window in the sty, which should be openable, and an air inlet through the wall, as shown in fig. 22.

The floor of the sty and yard should, of course, be made of concrete, and it is advisable to make the highest part of the yard floor about 2 in. lower than the bottom of that of the sty. There will thus be a small step between the two, which facilitates drainage. Both floors should slope toward the front, but they should also be inclined to the side as well —that of the sty from right to left, and that of the yard from left to right. They should further be provided with small channels placed diagonally in parallel lines (not cutting across one another in the manner known as cross hatching, which

leads to the accumulation of dirt). A small channel should lead from the pig's bed directly through the wall of the sty into the yard, and so on right down to the gate leading into the yard. By this method of drainage fluids tend to drain away from the pig's bed and trough, and collect opposite the

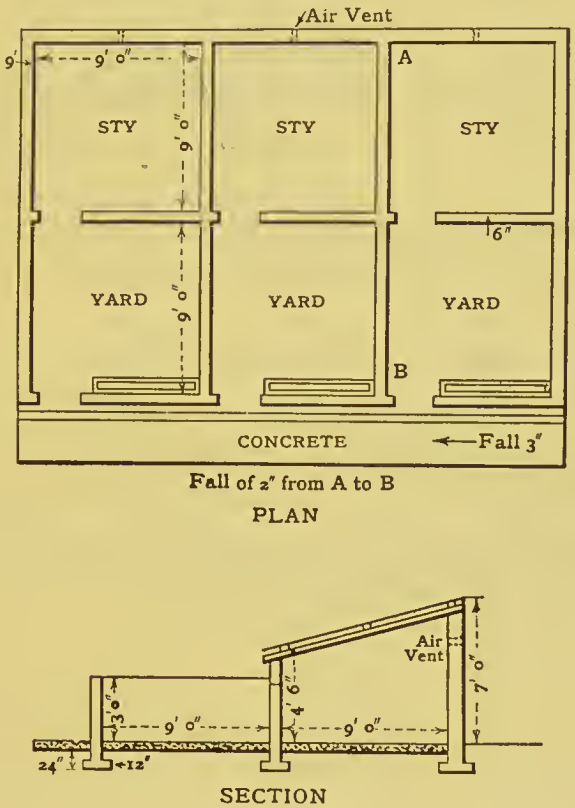


Fig. 23.—Piggery suitable for Small Farmer or Cottager

yard gate, from which they may be led directly into a trapped gully.

Where large numbers of pigs are kept they are generally housed in large buildings, with a passage down the centre and sties on either side (fig. 24).

While it is essential that pigs should be kept in a cleanly manner and that their houses should be constructed properly, it would seem that existing regulations can be enforced in too

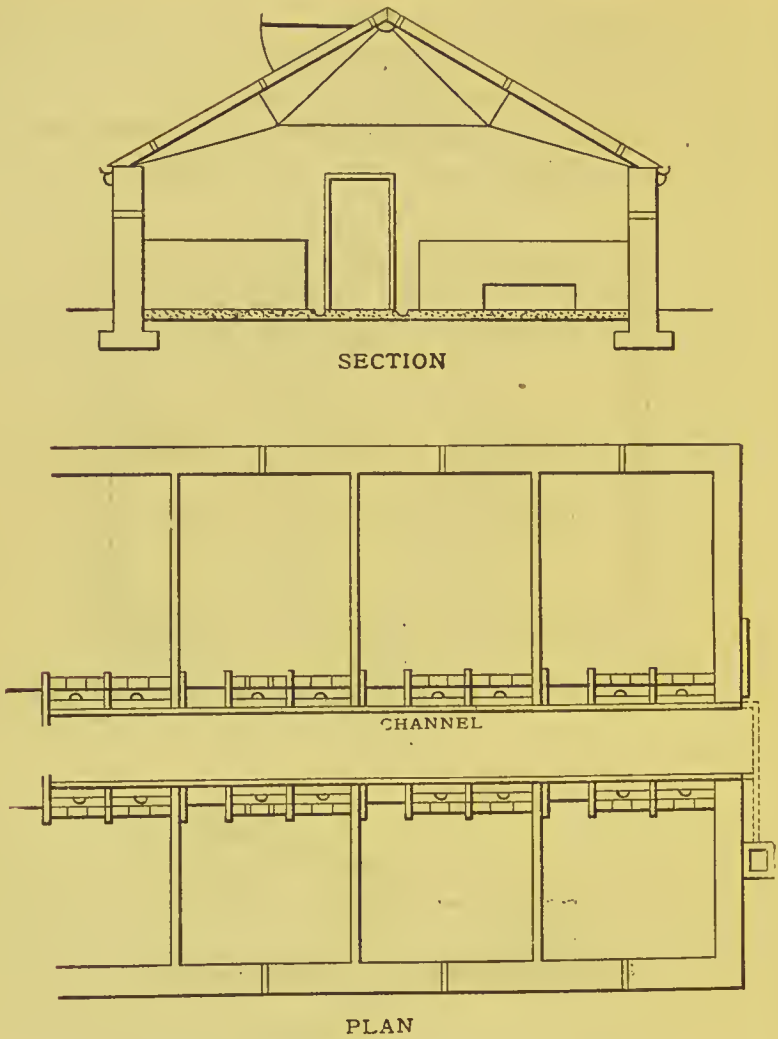


Fig. 24.—Piggery suitable for Large Breeder

drastic a manner, as pig-keeping has of recent years died out in many districts where it formerly flourished, and we have come to rely more and more on foreign pork. This is unfortunate, as the keeping of pigs may be a great boon and source of income to the poorer classes of the community.

LAW RELATING TO PIG STIES AND THE KEEPING OF ANIMALS

LIST OF ABBREVIATIONS USED IN LEGAL SECTIONS

Sec. = Section.
S.A. = Sanitary Authority.
P.H.A. = Public Health Act.
M.O.H. = Medical Officer of Health.
S.I. = Sanitary Inspector.
L.A. = Local Authority.
I.N. = Inspector of Nuisances.
L.G.B. = Local Government Board.
U.A. = Urban Authority.
(Adoptive) = An Act that may be adopted by a S.A.

ENGLAND AND WALES

Public Health Act, 1875, Sec. 44.—Any Urban S.A. may make by-laws for the prevention of the keeping of animals on any premises, so as to be injurious to health.

Sec. 47.—A penalty of 40*s.* may be imposed upon anyone who, in an urban district, keeps any swine or pig sty in any dwelling house, or so as to be a nuisance to any person.

Sec. 91 states that any animal kept so as to be a nuisance or injurious to health is a nuisance, and proceedings may be taken accordingly.

IRELAND

Public Health (Ireland) Act, Secs. 54, 57, and 107 (C), are the same as the above secs. of the Public Health Act, 1875.

LONDON

Public Health (London) Act, 1891, Sec. 2 (C).—Any animal kept in such a place or such a manner as to be a nuisance or dangerous to health is a nuisance, and proceedings may be taken accordingly.

Sec. 16.—The S.A. is empowered to make by-laws for the prevention of nuisance arising from the keeping of animals.

Sec. 17.—No person shall feed or keep swine in any place unfit for the purpose, or within 40 yards of any street or public place so as to cause a nuisance. No one shall permit swine to stray in any street or public place; such animals, if found, may be seized by a constable.

Contravention of the above entails a fine of 40*s.*, forfeiture of the swine, and a daily penalty for continuance after notice has been sent by the S.A.

Sec. 18.—A Court of Petty Sessions may prohibit the keeping of animals in any place deemed unfit for the purpose.

SCOTLAND

Public Health (Scotland) Act, 1897, Sec. 16 (Sub-Sec. 4).—Any stable, byre, or other building, in which any animal or animals are kept in such a manner, or in such numbers as to be a nuisance or injurious or dangerous to health, is a nuisance, and may be dealt with as such.

Sec. 35 gives power to L.A.'s to make by-laws for regulating (1) the construction of pig sties, (2) proper sites for such, (3) the mode of cleansing so as to prevent nuisance or danger to health.

The Burgh Police (Scotland) Act, Sec. 316, empowers the L.A. to make by-laws, (1) for providing that cattle (including swine, dogs, and poultry) shall not be kept in such places or in such a manner as to be a nuisance or annoyance to the inhabitants; (2) for prescribing the situation of places in which swine may be kept; (3) for prohibiting, on cause shown, the keeping of swine.

Sec. 381 provides that a penalty may be imposed on anyone in a burgh who keeps swine near any dwelling-house so as to be a nuisance or annoyance to the residents or passengers.

Model By-laws.—Power to make by-laws with regard to the keeping of animals is given by Sec. 44 of the Public Health Act, 1875, in England; Sec. 54 of the Act of 1878, in Ireland; and Sec. 16 of the London Act, in London. Sec. 35 of the Scotch Act gives power to make by-laws as to pig-sties.

These Model By-laws may be summarized as follows: Swine must not be kept within 100 ft. of any dwelling, nor cattle where they may pollute water likely to be used for drinking, domestic, or dairy purposes, or for manufacturing drinks. Similar prohibitions apply to the storage of dung. Premises in which swine, cattle, or horses are kept must be provided with proper receptacles for manure, which must be watertight, covered, and entirely above the level of the ground. Such receptacles must be efficiently drained, and the drain must be properly made and kept in good order at all times so as to convey all liquid filth to a sewer, cesspool, or other suitable receptacle. They must also be cleansed at least once a week.

PART IV

Law Relating to the Milk Trade

LAW RELATING TO THE MILK TRADE

ENGLAND AND WALES

Public Health Act, 1875, Sec. 117.
Markets Clauses Act, 1847, Sec. 15.
Contagious Diseases (Animals) Act, 1878, Sec. 34.
Contagious Diseases (Animals) Act, 1886.
Dairies, Cowsheds, and Milkshops Order, 1885.
Dairies, Cowsheds, and Milkshops (Amending) Order, 1886.
Dairies, Cowsheds, and Milkshops Order, 1889.
Model Regulations.
Infectious Diseases Prevention Act, 1890, Sec. 4.
(Local Acts—Manchester Milk Clauses, Liverpool Corporation Act, 1900.)

LONDON

Public Health (London) Act, 1891, Secs. 28 and 47.

SCOTLAND

Dairies, Cowsheds, and Milkshops Orders, 1885, 1887, 1889.
Model Regulations.
Public Health (Scotland) Act, 1897, Secs. 58, 60, and 61.
Cattlesheds in Burghs (Scotland) Act.

IRELAND

Dairies, Cowsheds, and Milkshops (Ireland) Orders.

ENGLAND AND WALES

Sec. 117 of the Public Health Act, 1875, and Sec. 15 of the Markets Clauses Act, 1847, enact that unwholesome articles of food, including milk, may be dealt with by seizure and condemnation. The Contagious Diseases (Animals) Act, 1878, Sec. 34, authorized the Privy Council to make orders for the purpose of regulating the trade of cowkeeping and dairying. The Privy Council therefore drew up an order for this purpose called the Dairies, Cowsheds, and Milkshops Order, 1885. An amending Act, the Contagious Diseases (Animals) Act, 1886, transferred to the L.G.B. the powers thus conferred upon the

Privy Council. The Dairies, Cowsheds, and Milkshops (Amending) Order, 1886, substituted the L.G.B. for the Privy Council, thus giving the Order the force of law. The Dairies, Cowsheds, and Milkshops Order, 1889, amended Sec. 15 of the 1885 Order so that it should include, in addition to the diseases scheduled under the Contagious Diseases (Animals) Acts, such disease of the udder as shall be certified by a veterinary surgeon to be tubercular. Thus for the first time tuberculosis was brought under control of the Order.

DAIRIES, COWSHEDS, AND MILKSHOPS ORDERS

The following are the chief provisions of the Dairies, Cowsheds, and Milkshops Order, 1885, as amended by that of 1886 and 1889:—

Registration of Dairymen and others

6.—(1) It shall not be lawful for any person to carry on in the District of any Local Authority the trade of cowkeeper, dairyman or purveyor of milk, unless he is registered as such therein in accordance with this Article.

(2) Every Local Authority shall keep a Register of such persons, and shall from time to time revise and correct the Register.

(3) The Local Authority shall register every such person, but the fact of such registration shall not be deemed to authorize such person to occupy as a dairy or cowshed any particular building, or in any way preclude any proceedings being taken against such person for non-compliance with or infringement of any of the provisions of this Order or any Regulation made thereunder.

(4) The Local Authority shall from time to time give public notice by advertisement in a newspaper circulating in their District, and, if they think fit, by placards, hand-bills, or otherwise, of registration being required, and of the mode of registration.

(5) A person who carries on the trade of cowkeeper or dairyman for the purpose only of making and selling butter or cheese or both, and who does not carry on the trade of purveyor of milk, shall not, for the purposes of registration, be deemed to be a person carrying on the trade of cowkeeper or dairyman, and need not be registered.

(6) A person who sells milk of his own cows in small quantities to his workmen or neighbours, for their accommodation, shall not, for the purposes of registration, be deemed, by reason only of such selling, to be a person carrying on the trade of cowkceper, dairyman or purveyor of milk, and need not, by reason thereof, be registered.

Construction and Water Supply of New Dairies and Cowsheds

7.—(1) It shall not be lawful for any person following the trade of cowkeeper or dairyman to begin to occupy as a dairy or cowshed any building not so occupied at the commencement of this Order, unless and

until he first makes provision, to the reasonable satisfaction of the Local Authority, for the lighting, and the ventilation including air space, and the cleansing, drainage, and water supply, of the same, while occupied as a dairy or cowshed.

(2) It shall not be lawful for any such person to begin so to occupy any such building without first giving one month's notice in writing to the Local Authority of his intention so to do.

Sanitary State of all Dairies and Cowsheds

8. It shall not be lawful for any person following the trade of cowkeeper or dairyman to occupy as a dairy or cowshed any building, whether so occupied at the commencement of this Order or not, if and as long as the lighting, and the ventilation including air space, and the cleansing, drainage, and water supply thereof, are not such as are necessary or proper—

(*a*) for the health and good condition of the cattle therein; and

(*b*) for the cleanliness of milk-vessels used therein for containing milk for sale; and

(*c*) for the protection of the milk therein against infection or contamination.

Contamination of Milk

9. It shall not be lawful for any person following the trade of cowkeeper or dairyman or purveyor of milk, or being the occupier of a milk-store or milkshop—

(*a*) to allow any person suffering from a dangerous infectious disorder, or having recently been in contact with a person so suffering, to milk cows or to handle vessels used for containing milk for sale or in any way to take part or assist in the conduct of the trade or business of the cowkeeper or dairyman, purveyor of milk, or occupier of a milk-store or milkshop, so far as regards the production, distribution, or storage of milk; or

(*b*) if himself so suffering or having recently been in contact as aforesaid, to milk cows, or handle vessels used for containing milk for sale, or in any way to take part in the conduct of his trade or business, as far as regards the production, distribution, or storage of milk—

until in each case all danger therefrom of the communication of infection to the milk or of its contamination has ceased.

10. It shall not be lawful for any person following the trade of cowkeeper or dairyman or purveyor of milk, or being the occupier of a milk-store or milkshop, after the receipt of notice of not less than one month from the Local Authority calling attention to the provisions of this Article, to permit any water-closet, earth-closet, privy, cesspool, or urinal

to be within, communicate directly with, or ventilate into any dairy or any room used as a milk-store or milkshop.

11. It shall not be lawful for any person following the trade of cowkeeper or dairyman or purveyor of milk, or being the occupier of a milk-store or milkshop, to use a milk-store or milkshop in his occupation, or permit the same to be used, as a sleeping apartment, or for any purpose incompatible with the proper preservation of the cleanliness of the milk-store or milkshop, and of the milk-vessels and milk therein, or in any manner likely to cause contamination of the milk therein.

12. It shall not be lawful for any person following the trade of cowkeeper or dairyman or purveyor of milk to keep any swine in any cowshed or other building used by him for keeping cows, or in any milk-store or other place used by him for keeping milk for sale.

Regulations of Local Authority

13. A Local Authority may from time to time make Regulations for the following purposes, or any of them:

(*a*) For the inspection of cattle in dairies.

(*b*) For prescribing and regulating the lighting, ventilation, cleansing, drainage, and water supply of dairies and cowsheds in the occupation of persons following the trade of cowkeepers or dairymen.

(*c*) For securing the cleanliness of milk-stores, milkshops, and of milk-vessels used for containing milk for sale by such persons.

(*d*) For prescribing precautions to be taken by purveyors of milk and persons selling milk by retail against infection or contamination.

Provisions as to Regulations of Local Authority

14. The following provisions shall apply to regulations made by a Local Authority under this Order:—

(1) Every Regulation shall be published by advertisement in a newspaper circulating in the District of the Local Authority.

(2) The Local Authority shall send to the L.G.B. a copy of every Regulation made by them not less than one month before the date named in such Regulation for the same to come into force.

(3) If at any time the L.G.B. are satisfied on enquiry, with respect to any Regulation, that the same is of too restrictive a character, or otherwise objectionable, and direct the revocation thereof, the same shall not come into operation, or shall thereupon cease to operate, as the case may be.

Existence of Disease among Cattle.—15. The milk of a cow suffering from cattle-plague, pleuro-pneumonia, or foot-and-mouth disease (*a*)

shall not be mixed with other milk; (*b*) shall not be sold or used for human food; and (*c*) shall not be used for food of animals, unless it has been boiled. Such disease of the udder as shall be certified by a veterinary surgeon to be tubercular is now included in this section under the D. C. & M. O., 1889.

MODEL REGULATIONS

The following Model Regulations under Sec. 13 of the Order have been drawn up by the English L.G.B. for Dairies, Cowsheds, and Milkshops:—

1. *Interpretation.*—The expression "Cowshed" includes any dairy in which milking cows may be kept, and the expression "Cowkeeper" means any person following the trade of a cowkeeper or dairyman who is, or is required to be, registered under the Dairies, Cowsheds, and Milkshops Order of 1885.

2. *For the Inspection of Cattle in Dairies.*—Every occupier of a dairy wherein any cattle may be kept, and which the Medical Officer of Health, or the Inspector of Nuisances, or any other officer of the Council specially authorized by them in that behalf, may visit for the purpose of inspecting cattle, and every person for the time being having the care or control of any such dairy, or of any cattle therein, shall afford such Medical Officer of Health, Inspector of Nuisances, or officer, all reasonable assistance that may, for the purpose of the inspection, be required by him.

For Prescribing and Regulating the Lighting, Ventilation, Cleansing, Drainage, and Water Supply of Cowsheds and Dairies in the Occupation of Persons following the Trade of Cowkeepers or Dairymen.

Part I

The Regulations in this Part shall apply to cowsheds, the cows from which are habitually grazed on grass land during the greater part of the year, and when not so grazed, are habitually turned out during a portion of each day.

3. *Lighting.*—Every cowkeeper shall provide that every cowshed in his occupation shall be sufficiently lighted with windows, whether in the sides or roof thereof.

4. *Ventilation.*—Every cowkeeper shall cause every cowshed in his occupation to be sufficiently ventilated, and for this purpose to be provided with a sufficient number of openings into the external air to keep the air in the cowshed in a wholesome condition.

5. *Cleansing.*—(1) Every cowkeeper shall cause every part of the interior of every cowshed in his occupation to be thoroughly cleansed from time to time as often as may be necessary to secure that such cowshed shall be at all times reasonably clean and sweet.

(2) Such persons shall cause the ceiling or interior of the roof, and the walls of every cowshed in his occupation, to be properly lime-washed *twice* at least in every year, that is to say, once during the month of May and once during the month of October, and at such other times as may be necessary.

Provided that this requirement shall not apply to any part of such ceiling, roof, or walls that may be properly painted, or varnished, or constructed of or covered with any material such as to render the lime-washing unsuitable or inexpedient, and that may be otherwise properly cleansed.

(3) He shall cause the floor of every such cowshed to be thoroughly swept, and all dung and other offensive matter to be removed from such cowshed as often as may be necessary, and not less than *once* in every day.

6. *Drainage.*—(1) Every cowkeeper shall cause the drainage of every cowshed in his occupation to be so arranged that all liquid matter which may fall or be cast upon the floor may be conveyed by a suitable open channel to a drain inlet situate in the open air at a proper distance from any door or window of such cowshed, or to some other suitable place of disposal which is so situate.

(2) He shall not cause or suffer any inlet to any drain of such cowshed to be within such cowshed.

7. *Water Supply.*—(1) Every cowkeeper shall keep in, or in connection with, every cowshed in his occupation a supply of water suitable and sufficient for all such purposes as may from time to time be reasonably necessary.

(2) He shall cause any receptacle which may be provided for such water to be emptied and thoroughly cleansed from time to time as often as may be necessary to prevent the pollution of any water that may be stored therein, and where such receptacle is used for the storage only of water he shall cause it to be properly covered and ventilated, and so placed as to be at all times readily accessible.

Part II

The regulations in Part I, and also the following regulation, shall apply to all cowsheds other than those the cows from which are habitually grazed on grass land during the greater part of the year, and, when not so grazed, are habitually turned out during a portion of each day.

8. A cowkeeper shall not cause or allow any cowshed in his occupation to be occupied by a larger number of cows than will leave not less than *eight hundred feet* of air space for each cow.

Provided as follows:—

(*a*) In calculating the air space for the purposes of this regulation, no space shall be reckoned which is more than *sixteen feet* above the floor; but if the roof or ceiling is inclined, then

the mean height of the same above the floor may be taken as the height thereof for the purposes of this regulation.

(*b*) This regulation shall not apply to any cowshed constructed and used before the date of these regulations coming into effect, until two years after that date.

Part III

9. In this part the expression "Dairy" means a dairy in which cattle are not kept.

10. *Lighting.*—Every cowkeeper shall provide that every dairy in his occupation shall be sufficiently lighted with windows, whether in the sides or roof thereof.

11. *Ventilation.*—Every cowkeeper shall cause every dairy in his occupation to be sufficiently ventilated, and for this purpose to be provided with a sufficient number of openings into the external air to keep the air in the dairy in a wholesome condition.

12. *Cleansing.*—(1) Every cowkeeper shall cause every part of the interior of every dairy in his occupation to be thoroughly cleansed from time to time as often as may be necessary to secure that such dairy shall be at all times reasonably clean and sweet.

(2) He shall cause the floor of every such dairy to be thoroughly cleansed with water at least *once* in every day.

13. *Drainage.*—(1) Every cowkeeper shall cause the drainage of every dairy in his occupation to be so arranged that all liquid matter which may fall or be cast upon the floor may be conveyed by a suitable open channel to the outside of such dairy, and may there be received in a suitable gully communicating with a proper and sufficient drain.

(2) He shall not cause or suffer any inlet to any drain of such dairy to be within such dairy.

14. *Water Supply.*—(1) Every cowkeeper shall cause every dairy in his occupation to be provided with an adequate supply of good and wholesome water for the cleansing of such dairy and of any vessels that may be used therein for containing milk, and for all other reasonable and necessary purposes in connection with the use thereof.

(2) He shall cause every cistern or other receptacle in which any such water may be stored to be properly covered and ventilated, and so placed as to be at all times readily accessible.

(3) He shall cause every such cistern or receptacle to be emptied and thoroughly cleansed from time to time as often as may be necessary to prevent the pollution of any water that may be stored therein.

For Securing the Cleanliness of Milk-stores, Milkshops, and of Milk-vessels used for containing Milk for Sale by Persons following the Trade of Cowkeepers or Dairymen.

15. *Cleanliness of Milk-stores and Milkshops.*—Every cowkeeper

who is the occupier of a milk-store or milkshop shall cause every part of the interior of such milk-store or milkshop to be thoroughly cleansed from time to time as often as may be necessary to maintain such milk-store or milkshop in a thorough state of cleanliness.

16. *Cleanliness of Milk-vessels.*—(1) Every cowkeeper shall from time to time as often as may be necessary cause every milk-vessel that may be used by him for containing milk for sale to be thoroughly cleansed with steam or clean boiling water, and shall otherwise take all proper precautions for the maintenance of such milk-vessel in a constant state of cleanliness.

(2) He shall, on every occasion when any such vessel shall have been used to contain milk, or shall have been returned to him after having been out of his possession, cause such vessel to be forthwith so cleansed.

For Prescribing Precautions to be taken by Purveyors of Milk and Persons Selling Milk by Retail against Infection or Contamination.

17.—(1) Every purveyor of milk or person selling milk by retail shall take all reasonable and proper precautions in, and in connection with, the storage and distribution of the milk, and otherwise, to prevent the exposure of the milk to any infection or contamination.

(2) He shall not deposit or keep any milk intended for sale—

(*a*) in any room or place where it would be liable to become infected or contaminated by impure air, or by any offensive, noxious, or deleterious gas or substance, or by any noxious or injurious emanation, exhalation, or effluvium; or

(*b*) in any room used as a kitchen or as a living room; or

(*c*) in any room or building, or part of a building communicating directly by door, window, or otherwise with any room used as a sleeping room, or in which there may be any person suffering from any infectious or contagious disease, or which may have been used by any person suffering from any such disease and may not have been properly disinfected; or

(*d*) in any room or building or part of a building in which there may be any direct inlet to any drain.

(3) He shall not keep milk for sale, or cause or suffer any such milk to be placed, in any vessel, receptacle, or utensil which is not thoroughly clean.

(4) He shall cause every vessel, receptacle, or utensil used by him for containing milk for sale to be thoroughly cleansed with steam or clean boiling water after it shall have been used, and to be maintained in a constant state of cleanliness.

(5) He shall not cause or suffer any cow belonging to him or under his care or control to be milked for the purpose of obtaining milk for sale—

(*a*) Unless, at the time of milking, the udder and teats of such cow are thoroughly clean; and

(*b*) Unless the hands of the person milking such cow, also, are thoroughly clean and free from all infection and contamination.

18. *Penalties.*—Every person who shall offend against any of the foregoing regulations shall be liable for every such offence to a penalty of *five pounds*, and in the case of a continuing offence to a further penalty of *forty shillings* for each day after written notice of the offence from the Council.

Provided, nevertheless, that the justices, or court before whom any complaint may be made or any proceedings may be taken in respect of any such offence may, if they think fit, adjudge the payment as a penalty of any sum less than the full amount of the penalty imposed by this regulation.

The Dairies Order is the chief legislation dealing with the milk trade. The Infectious Diseases Prevention Act has, however, also a section devoted to this subject.

The Infectious Diseases Prevention Act, 1890, is an adoptive Act. Sec. 4 deals with milk supplies. If the M.O.H. is in possession of evidence that milk from any dairy, cowshed, milkshop, &c., has caused or is likely to cause infectious disease in the district, he may (if authorized by a justice having jurisdiction in the place where the dairy is situate) inspect the dairy. If accompanied by a veterinary surgeon, he may inspect the animals therein. If after inspection he believes that disease is caused by consumption of the milk, he must report to the S.A., forwarding also the veterinary surgeon's report. The S.A. may then give the dairyman twenty-four hours' notice in which to appear before them and show cause why the supply of milk in their district should not be prohibited. If he does not show cause to their satisfaction, they may order accordingly, and must give notice of the facts to the S.A. and County Council of the district in which the dairy is situate, and to the L.G.B. The order must be forthwith withdrawn as soon as the S.A. or M.O.H. are satisfied that the milk supply has been changed, or that the cause of infection has been removed. Penalties are provided for contravention of this section of the Act.

LOCAL ACTS

In addition to the above Acts there are various local Acts dealing with the milk supply. What is known as the Manchester Milk Clauses and the Liverpool Corporation Act, 1900, are examples of such legislation. The terms of the Manchester Milk Clauses and the Liverpool

Corporation Act are very similar. The following are the more important provisions of the latter:—

18.—Every person who knowingly sells or suffers to be sold or used for human consumption within the city the milk of any cow which is suffering from tuberculosis of the udder shall be liable to a penalty not exceeding ten pounds.

19.—Any person the milk of the cows in whose dairy is sold or suffered to be sold or used for human consumption within the city who, after becoming aware that any cow in his dairy is suffering from tuberculosis of the udder, keeps or permits to be kept such cow in any field, shed, or premises along with other cows in milk, shall be liable to a penalty not exceeding five pounds.

20.—Every dairyman who supplies milk within the city, and has in his dairy any cow affected with, or suspected of, or exhibiting signs of tuberculosis of the udder, shall forthwith give written notice of the fact to the medical officer, stating his name and address and the situation of the dairy or premises where the cow is. Any dairyman failing to give such notice shall be liable to a penalty not exceeding forty shillings.

21.—(1) It shall be lawful for the medical officer or any person provided with, and, if required, exhibiting the authority in writing of such medical officer, to take within the city for examination samples of milk produced or sold or intended for sale within the city.

(2) The like powers in all respects may be exercised outside the city by the medical officer, or such authorized person, if he shall first have obtained from a justice having jurisdiction in the place where the sample is to be taken an order authorizing the taking of samples of the milk, which order any such justice is hereby empowered to make.

22.—(1) If milk from a dairy situate within the city is being sold or suffered to be sold or used within the city the medical officer or any person provided with, and, if required, exhibiting the authority in writing of the medical officer, may, if accompanied by a properly qualified veterinary surgeon, at all reasonable hours enter the dairy and inspect the cows kept therein; and if the medical officer or such person has reason to suspect that any cow in the dairy is suffering from tuberculosis of the udder he may require the cow to be milked in his presence, and may take samples of the milk, and the milk from any particular teat shall, if he so requires, be kept separate, and separate samples thereof be furnished.

(2) If the medical officer is of opinion that tuberculosis is caused or is likely to be caused to persons residing in the city from consumption of the milk supplied from a dairy situate within the city or from any cow kept therein, he shall report thereon to the Corporation, and his report shall be accompanied by any report furnished to him by the veterinary surgeon, and the Corporation may thereupon serve on the dairyman notice to appear before them within such time, not less than twenty-four hours, as may be specified in the notice, to show cause why

an order should not be made requiring him not to supply any milk from such dairy within the city until the order has been withdrawn by the Corporation.

(3) If the medical officer has reason to believe that milk from any dairy situate outside the city from which milk is being sold or suffered to be sold or used within the city is likely to cause tuberculosis in persons residing within the city, the powers conferred by this section may in all respects be exercised in the case of such dairy, provided that the medical officer or other authorized person shall first have obtained from a justice having jurisdiction in the place where the dairy is situate an order authorizing such entry and inspection, which order any such justice is hereby empowered to make.

(4) Every dairyman and the persons in his employment shall render such reasonable assistance to the medical officer or such authorized person or veterinary surgeon as aforesaid as may be required by such medical officer, person, or veterinary surgeon for all or any of the purposes of this section, and any person refusing such assistance or obstructing such medical officer, person, or veterinary surgeon in carrying out the purposes of this section shall be liable to a penalty not exceeding five pounds.

(5) If in their opinion the dairyman fails to show cause why such an order may not be made as aforesaid, the Corporation may make the said order, and shall forthwith serve notice of the facts on the County Council of any administrative county in which the dairy is situate and on the Local Government Board, and if the dairy is situate outside the city, on the council of the borough or county district in which it is situate.

(6) The said order shall be forthwith withdrawn on the Corporation or their medical officer being satisfied that the milk supply has been changed, or that it is not likely to cause tuberculosis to persons residing in the city.

(7) If any person after any such order has been made supplies any milk within the city in contravention of the order, or sells it for consumption therein, he shall be liable to a penalty not exceeding five pounds, and if the offence continues to a further penalty not exceeding forty shillings for every day during which the offence continues.

(8) A dairyman shall not be liable to an action for breach of contract if the breach be due to an order under this section.

LONDON

The Public Health (London) Act, 1891, Sec. 28, enacts that all persons carrying on the trade of dairymen must be registered with the Metropolitan Boroughs Councils. The remainder of this section is very similar to the clauses of the Dairies Order which deal with registration.

Sec. 47 empowers Metropolitan S.A.'s to inspect, examine, and seize

"any article of food, whether solid or liquid, intended for the food of man". This, of course, includes milk.

Sec. 71 is substantially the same as Sec. 4 of the Infectious Diseases Prevention Act.

SCOTLAND

The Dairies, Cowsheds, and Milkshops Order, 1885, applies to Scotland as well as to England and Wales. The Dairies, Cowsheds, and Milkshops (Amending) Order of 1887 is similar to the English Order of 1886. The Dairies, Cowsheds, and Milkshops Order of 1899 issued by the Scotch L.G.B. is similar to the English Order of 1889.

MODEL REGULATIONS

The Model Regulations issued by the Scotch L.G.B. are on the same lines as those of the English L.G.B., but are considerably fuller and more explicit. In addition to the provisions of the English Regulations, those issued by the Scotch L.G.B. contain the following:—

Cowsheds, Lighting, Ventilation, and Floor Space.—There must be 3 sq. ft. of window space for every 800 c. ft. of space in the cowshed. The openings for ventilation must have an area of 36 sq. in. for every 800 c. ft. A floor space of 50 sq. ft. per cow must be provided. Inner surface of walls must be covered to a height of not less than 6 ft. from the floor with a smooth impervious material such as tiles or cement.

The troughs shall be made of a smooth impervious material such as enamelled earthenware, and shall be set with a sufficient slope so as to be readily cleansed.

The trevases in the cowshed shall be constructed of or covered with some smooth impervious material.

Cleansing.—All dung and refuse must be removed from the cowshed twice daily. The surface of every yard and passage in connection with a dairy or cowshed must be kept in such a condition and so drained as to be easily cleaned, and must be kept in a clean and wholesome condition. All dung and refuse must be deposited in an outside receptacle situated at a distance of not less than 10 yds. from any cowshed. The sides and bottom of such receptacle shall be made of hard smooth impervious materials; it shall be roofed over to prevent access of rain, but not so as to prevent free ventilation; if required by the L.A., it shall be drained; and it shall be emptied once a fortnight, or as often as required by the L.A.

Drainage.—The floor of every cowshed must be well paved with concrete, asphalt, granolithic, or other approved impervious material, and laid with an adequate fall to the grips or channels, which shall be at least 20 in. wide, and so constructed that no liquid matter can percolate into the soil under the floor. The grips or channels shall be formed with a proper and uniform slope to a drain, which shall be carefully trapped outside the cowshed.

Milkshops and Dairies.—Any milk-store, milkshop, dairy, or other place where milk is kept or exposed for sale must be properly lighted and ventilated, and so situated as not to be exposed to the effluvium of any ashpit, dungstead, cowshed, washhouse, or other source likely to cause contamination of the milk. It must not have internal communication by a door, window, room, passage, or otherwise with a dwelling or sleeping room, or communicate directly or through any apartment or any enclosed passage with any cowshed or place where animals of any kind are kept.

Where the walls or ceiling are limewashed or size-coloured, the limewash or size colour shall be renewed at least every six months, or oftener if specially requested by the L.A.; and where walls are painted or varnished, the paint or varnish shall be washed as often as required to keep the same clean, and shall be renewed every two years. The plasterwork, flooring, and woodwork of such premises shall be kept in a thorough state of repair.

Precautions against Infection or Contamination.—Nothing likely to cause contamination must be kept in, and no foul matter or any soiled bed or body clothing shall be carried into or through any milk-store, dairy, or other place where milk is kept or exposed for sale. Milk must not be kept in any apartment used for washing, mangling, or drying clothes, or for any purpose likely to cause its contamination. No apartment or furniture therein or fittings thereof shall be cleansed, swept, or dusted when milk is exposed therein in open vessels. During such operations means must be taken to allay or keep down dust. No article or thing that is of such a nature as to be likely to contaminate the milk shall be conveyed by any cart or vehicle used in the distribution of milk.

Boilers and Milk Vessels.—Any boiler, tank, steam chest, or other receptacle used for scalding or washing milk vessels, cans, &c., shall not be employed for washing or boiling bed or body clothing, or for any other purpose likely to cause contamination of the milk. The barrels, butts, cans, or other vessels used to contain milk for sale must not be used for any other purpose likely to cause contamination of the milk. No one shall sit or rest his body, or permit any other person to sit or rest his body or feet on any milk barrel, milk tin, or milk vessel.

Cows and Milking.—The cows must be kept clean, and their udders and teats and the hands of the milkers properly cleansed and free from all infection or contamination before milking is commenced. Immediately after milking, all milk must be filtered by passing it through a sieve or otherwise; it must be removed without delay from the cowshed in the vessel in which it has been milked. No milk vessel shall be retained or filled within the cowshed. There must not be kept in any dairy or cowshed, where cows are stalled whose milk is sold or used for human food, any cow or other animal suffering from any disease which might render such milk liable to infection or contamination, and any stall

in which any such animal has been stalled must be thoroughly cleaned and disinfected immediately on removal of the cow or animal so suffering. No material previously used as bedding for horses or other animals, nor any sawdust, wood refuse, moss litter, or other material likely to cause contamination of the milk must be used as bedding for the cows.

Employees.—All persons employed or engaged in the production or selling of milk must at all times keep their persons and clothing in a thoroughly clean condition.

Public Health (Scotland) Act, 1897.—The Public Health (Scotland) Act, 1897, is the most recent Public Health Act in the United Kingdom. The sections dealing with milk are similar to some of those already considered, but contain certain important differences which greatly increase their usefulness. It may, indeed, be said that the milk sections of this Act are the most advanced general legal measures in the United Kingdom.

Sec. 58.—No person suffering from an infectious disease, or who is living in an infected house, shall milk any animal, or pick fruit, or shall engage in any occupation connected with food, or carry on any trade or business in such a manner as to be likely to spread such disease, and any person who knowing himself to be so suffering contravenes this section shall be liable to a penalty not exceeding £10.

Sec. 60 is similar to Sec. 4 of the Infectious Diseases Prevention Act, 1890, and Sec. 71 of the Public Health (London) Act, 1891, but with these two important differences: (1) An order from a justice is unnecessary. (2) The M.O.H. may act if he thinks "the milk from any such dairy is likely to cause disease and not only has caused disease".

Sec. 61 empowers the S.A., on representation by the M.O.H. or a medical practitioner that the outbreak or spread of infectious disease is attributable to milk, to require the dairyman, whether within or without the district, to furnish to them within a specified time, not being less than twenty-four hours, a list of his customers, for which he shall be paid at the rate of sixpence for every twenty-five names, and also the names and addresses of farmers or others from whom his milk is obtained, and, if required, to show to the M.O.H. or any person deputed by him all invoices, contracts, &c., relating thereto.

Cattlesheds in Burghs (Scotland) Act, 1866.—The chief provisions of this Act may be summarized as follows:—

1. The Magistrates of Royal and Parliamentary Burghs in Scotland must cause all cattlesheds and cowhouses and byres within their Burghs to be inspected by an officer appointed by them, and if found suitable to be licensed for one year. The Magistrates may also from time to time make rules and regulations for the proper sanitary condition of the same, and the number of cattle which may be kept in each cattle-shed, &c., must be specified in each licence. Any person keeping cattle in unlicensed premises, or violating any conditions of such licence, or any rules and regulations of the Magistrates, is liable to a penalty.

2. In the case of Burghs (other than Royal or Parliamentary Burghs) and populous places in Scotland which have adopted the whole or portions of the Police and Improvement (Scotland) Act, 1862, or previously to the passing of the said Act of 1862 had adopted the whole or any parts of the Police of Towns (Scotland) Act, the Commissioners under the said Acts may exercise similar powers to those given to Magistrates above.

3. If the owner or occupier of a cattleshed, &c., be convicted of non-observance of any regulations made by virtue of this Act, he may receive written notice from the Magistrates before whom he is charged requiring him to make such sanitary improvements in the same as they shall direct within one month from the receipt of such notice. In cases of non-compliance he may be fined and have his licence suspended for one month, and on conviction for a second or subsequent offence his licence may be revoked. The Magistrates or Commissioners may refuse to grant any licence whatsoever to the person whose licence has been so revoked.

4. All licences must be renewed every year. Before any licence for the use of any cattleshed can be granted, fourteen days notice of the intention to apply for the same shall be given in writing to the Magistrates or Commissioners.

IRELAND

Under Sec. 34 of the Contagious Diseases (Animals) Act, 1878, which applies to Ireland as well as to the United Kingdom, the Dairies, Cowsheds, and Milkshops (Ireland) Order was issued. This Order, modified by other Orders issued in 1886, 1894, and 1899, is very similar to the English Order of 1885. Articles 6 and 7 of the English Order correspond to 7 and 5 of the Irish; while articles 8, 9, 11, 12, and 15 of the English are the same as 6, 9, 10, 11, and 18 of the Irish. Articles 10 and 14 of the English Order are not represented in the Irish Order. Similar provisions as those contained in Article 13 of the English Order are placed in Article 7 of the Irish Order.

Penalties are recoverable for offences against the Irish Order under Secs. 60 and 61 of the Public Health (Ireland) Act, 1878, there being no Irish Amending Order like that of the English one of 1881. Sec. 118 of the Public Health (Ireland) Act gives similar powers to that of Sec. 102 of the English Act of 1875.

PART V

Dairy Products and Margarine

CHAPTER I

Butter, Margarine, Cheese, and Eggs

Butter — Composition of — Mode of Preparation — The Use of "Starters"—Comparison of British with Foreign Dairy Products —Method of Inspecting Butter—A Simple Test for Butter—Butter in Relation to Disease.

Margarine—Preparation of—Composition—Margarine in Relation to Disease.

Cheese—Mode of Preparation—Ripening—Use of "Starters", &c.

Eggs—Tests for Freshness—Candling—Packing of Eggs—Preservation of Eggs.

BUTTER

The Margarine Act defines "butter" as made exclusively from milk or cream, or both, with or without preservative, and with or without added colouring matter.

Composition.—Butter is composed of the fat of milk clotted together, along with water, and small amounts of casein and salts. It contains about 85 per cent of fat, 2·5 per cent of casein, and 8 to 12 per cent of water. The characteristic flavour of butter is due to the presence of the soluble and volatile butyric, caproic, and caprylic acids, which together constitute about 7 to 8 per cent of butter fat, the rest being composed of the insoluble non-volatile oleic, stearic, and palmitic acids.

Mode of Preparation.—Milk or cream from which butter is to be prepared is first allowed to "ripen" or turn sour. This souring process is produced by the action of lactic-acid organisms, and much depends upon the particular species of organism as to whether the butter will be good and pleasantly flavoured or not. It is probable that, in dairies where fine butter is habitually made, the atmosphere is impregnated with

the necessary bacteria, and in others where inferior butter is produced the wrong sorts of organisms are present in excessive numbers, to the exclusion of the beneficial ones. As a result of scientific investigation the good bacteria have been isolated from the bad, and it is now possible to buy pure cultures of lactic-acid bacilli for the purpose of ripening the cream. The rationale of the process lies in cultivating the sort or sorts of bacteria that are essential to the production of fine butter and in excluding those that do harm. A certain quantity of this culture of beneficial bacteria, called the "starter", added to the milk or cream some time before churning, causes it to ripen and imparts a pleasant flavour to the butter made therefrom. To produce the best results this ripening must be carried out with care. During the process the milk or cream must be kept at an even temperature—neither too hot nor too cold—and must be churned as soon as it is fully ripe, but not before then. If it be left too long after ripening, the butter will not turn out well. In order, as far as possible, to get rid of harmful bacteria, the milk or cream is sometimes pasteurized before the starter is added. The next process is that of churning. When the ripened milk is violently agitated in a churn, the fat globules of the milk are ruptured, and the freed fat coalesces into granular particles, which are then separated from the residual buttermilk as butter. The butter is then "worked" in a butter-worker so as to expel as much buttermilk as possible, after which it is made into prints or pats, or salted and packed in bulk in boxes or barrels. Butter after leaving the churn should never come in contact with the hand of the dairymaid, but should be manipulated with "wooden hands" as they are called, so as to avoid contamination. In the making of butter the greatest care and attention must be devoted to absolute cleanliness, otherwise the butter is apt to have an unpleasant taste. It has long been believed that the "turnipy" and most disagreeable flavours in butter (that has not been kept unduly) are due to the materials upon which the cows are fed. This is true to a certain extent, but it has been found that special micro-organisms which, as a result of

want of cleanliness, have found their way into the milk or cream, may set up a decomposition leading to the production of a taint.

Even if strict precautions as to cleanliness be observed, butter may still be improperly made. Thus the casein in carelessly made butter may exceed 2·5 per cent. When the amount of casein is large the butter keeps badly, rancidity being brought about by the decomposition of the casein. Again, if it be insufficiently worked it may contain an excess of moisture. The Sale of Butter Regulations state that where a sample of butter contains more than 16 per cent of water it shall be presumed, until the contrary is proved, that the butter is not genuine by reason of the excessive amount of water therein.

Nearly all butters are coloured by anatto or other harmless agent, such colouring being sanctioned by law.

Comparison of British with Foreign Dairy Products.—Uniformity in the quality and character of dairy products is very important. This is one of the chief reasons why Continental butter and American cheese have obtained so much favour with provision merchants in this country. In Britain, as a general rule, each farmer makes his own butter and cheese. The product of some farms is excellent; of others moderately good; and of others fair; thus the quality of home butter and cheese is very variable and cannot be depended upon. Uniformity is obtained in Denmark by means of co-operative dairies or creameries to which all the farmers in a district send their milk. It is not surprising that such creameries—fitted up in an appropriate manner, doing things on a very large scale, and managed by specially trained men—succeed in turning out butter more uniform in quality than can be accomplished by individual farmers in this country. The same result is obtained in France by blending butters on a large scale; and in America, in the case of cheese, by manufacturing it in factories. It is not that the quality of our home butter and cheese is inferior to that produced abroad — the best British dairy products will compare favourably with those

from any other country—it is merely the lack of uniformity of much of the butter and cheese made in British farmhouses that is responsible for loss to British farmers. Our moist but equable climate produces pastures which, if properly utilized, would yield the finest dairy products obtainable.

Method of Inspecting Butter.—The quality of butter is generally tested by the sense of smell and taste. In the case of barrels or kegs of salt butter, a long pale may be run into the butter and a sample thus obtained.

Adulteration.—The chief forms of adulteration are the substitution of foreign fat and the addition of water.

Simple Test for Butter.—Place a small sample of butter in a tablespoon. Hold the latter over a hot flame so that the butter may be boiled briskly. After boiling has commenced, stir the melted contents with a small piece of wood. If the sample be butter, a mass of foam is produced and the boiling is unattended by much noise; if, on the other hand, it is adulterated it will splutter violently and very little foam will appear. This may be taken as a very rough test, but too much reliance must not be placed upon it.

Butter in Relation to Disease.—Good butter is the most digestible form of fat; rancid butter may give rise to dyspepsia and diarrhœa. An outbreak of diarrhœa in a large hospital was traced by Sir Shirley Murphy to the consumption of a particular butter—the symptoms resembled those of tyrotoxicon poisoning. "Butter, buttermilk, and whey obtained from the milk of cows with tubercular udders may contain virulent tubercle bacilli for over one week after being prepared" (Delephine & Sellers). According to Swithinbank & Newman,[1] of 498 samples of butter examined by various observers, 15 per cent contained tubercle bacilli

MARGARINE

The Margarine Act defines "Margarine" as including all substances, whether compounds or otherwise, prepared in imitation of butter, and whether mixed with butter or not. It

[1] *Bacteriology of Milk*, p. 221.

is unlawful to manufacture, sell, expose for sale, or import any margarine, the fat of which contains more than 10 per cent of butter fat.

Margarine is made from fats, chiefly of animal origin, which are first washed, then cut into fine pieces by machinery, and subjected to a temperature of about 110° F. for several hours so that the fat may separate from the tissue. They are next drawn off and cooled for a time to 80° or 90° F., at which temperature the stearin solidifies and is separated from the oleo oil. The latter is churned with milk, and a certain proportion of genuine butter is frequently mixed with it in order to make it resemble butter in appearance and flavour.

Composition.—Margarine differs from butter in containing only very small amounts of soluble fatty acids, being composed chiefly of olein, stearin, and palmitin. The very small proportion of soluble fatty acids enables the analyst to distinguish between margarine and butter. The nutritive value of margarine when well prepared is probably little inferior to butter, but it is not so easy to digest.

Margarine in Relation to Disease.—But little is known on this subject. Much of the fat used in the manufacture of margarine is of mesenteric origin, besides being derived from other internal fatty tissues. Mesenteries contain many lymphatic glands (which may be tubercular). In the process of manufacture they are subjected to a temperature of about 110° F.—quite insufficient to kill the tubercle bacillus. The careful inspection of all materials used in the manufacture of margarine is therefore a matter of importance, so as to prevent the possibility of tubercle being conveyed by ingestion of that substance.

CHEESE

Cheese consists of coagulated casein derived from milk, with varying proportions of fats and salts. There are many different varieties of cheese; some are made from whole milk, others from skim milk, and others, again, from whole milk to which cream has been added. Thus Cheddar, Cheshire,

double Gloucester, and most American cheeses are made from whole milk, while Stilton is made from whole milk to which cream has been added. Dutch, Suffolk, and Somersetshire cheeses are made from skimmed milk.

Mode of Preparation.—In the manufacture of cheese, milk is heated to about 80° F. and then curdled by the action of rennet. When the coagulation is completed, the curd is cut or broken into small pieces and the whey is drawn off. The curd is then gathered into a mass and allowed to stand for an hour or more, during which time it increases in acidity, and this helps it to harden, and promotes the separation of the whey. When the curd gets into the proper consistence it is placed in a cheese-press and subjected to gradually-increasing pressure, after which it is removed and allowed to cure.

When cheese is kept under suitable conditions of temperature it undergoes a process of "ripening", which improves its flavour. This ripening is due to the action of micro-organisms, and the particular flavour produced thereby is dependent upon the kinds of organism and the numbers in which they are present. As a result of investigation, much may now be done in the way of flavouring cheese by introducing favourable organisms as "starters" of the desired fermentation. Ripening is best carried on at a temperature of about 70° F. It is a process of decomposition brought about by the action of enzymes, bacteria, and moulds. The casein undergoes a fatty metamorphosis, and the calcium phosphate reacts upon the fats and casein, producing lime salts of fatty acids and a soluble compound of casein with phosphoric acid. To produce the same kind of cheese the same varieties of organisms must be present, and the variety responsible for the particular flavour must have conditions favourable to its predominance. Occasionally the ripening process goes wrong, with the result that "gassy", "bitter", or "coloured" cheese may be produced. Tyrotoxicon is also occasionally formed in cheese as a result of some abnormal fermentation.

EGGS

A fresh egg should have no unpleasant smell. When eggs are kept they undergo evaporation, with the formation of a space at one end, and the longer they are kept the greater does this space become. Their freshness may, therefore, be determined by placing them in a 10-per-cent saline solution, when if perfectly fresh they will sink, but if stale they will float near the surface.

Another mode of testing is to place the egg against a light, when if perfectly fresh it presents a uniform rosy appearance. If stale, the space at one end will be seen. In a decomposing egg the yoke clings to the shell, and spots or a uniform dark colour may appear.

Candling.—Advantage is taken of the latter method of egg testing in the process known as "candling", as the sorting of eggs on a large scale is called. A special apparatus is employed for the purpose. The inspector stands in a dark compartment, and the eggs are made to pass between him and a light, by which means unsound or stale eggs are detected.

Packing of Eggs.—Eggs are generally packed in oat straw, fine shavings, or wood wool, the last mentioned being the best material for the purpose. Eggs should be carefully cleansed and freed from adherent matter before being sent to market, as dirty eggs present a very uninviting appearance, and become bad much more rapidly than clean ones.

An enormous number of eggs are annually imported into this country from abroad, especially from Russia, Denmark, Germany, Belgium, Canada, &c.

Preservation of Eggs.—The porous nature of the egg shell favours the deterioration of the egg by admitting microbes into its interior. The preservation of eggs may, therefore, be accomplished by coating their exteriors with a film of some material capable of rendering the shells impervious. Many substances are employed for this purpose, one

of the commonest being lime. Eggs to be preserved by this substance are placed in a solution of lime and water. While eggs that are to be preserved should be in as fresh a condition as possible, at least twelve hours after laying should be allowed to elapse before they are immersed in the solution in order that the animal heat may pass out of them.

Many other methods of coating eggs are employed, such as dipping them in a solution of soluble glass, &c. The preserving action in all is, however, dependent upon the same principle. The action of cold is now very extensively employed for the preservation of eggs. It is stated that, if they are packed in boxes not containing more than 300 eggs, and that if each layer of eggs is separated from the others by straw board as well as wood shavings, eggs may be kept in good condition at a temperature of about 30° F. for a period of six months.

CHAPTER II

Law Relating to the Adulteration of Food

The chief enactments relating to this matter in the British Isles are as follows:—

Sale of Food and Drugs Act, 1875 Sale of Food and Drugs Act Amendment Act, 1879 Margarine Act, 1887	Applicable to Great Britain and Ireland.
Sale of Food and Drugs Act, 1899 Sale of Milk Regulations, 1901 Sale of Butter Regulations, 1902	Applicable to the United Kingdom only.

Sale of Food and Drugs Act, 1875.—Sec. 2 of this Act defines "food" as including every article used for food or drink by man, other than drugs or water; and "drugs" as including medicine for external as well as internal use. Sec. 3.—"No person shall mix, colour, stain, or powder, or order or permit any other person to mix, colour, stain, or powder any article of food with any ingredient or material so as to render the article injurious to health, with intent that the same may be sold in that state, and no person shall sell any such article so mixed, coloured, stained, or powdered. . . . ." Sec. 4.—"No person shall, except for the purpose of compounding, ... mix, colour, stain, or powder, or order or permit any other person to mix, colour, stain, or powder, any drug with any ingredient or material so as to affect injuriously the quality or potency of such drug, with intent that the same may be sold in that state, and no person shall sell any such drug so mixed, coloured, stained, or powdered." The penalty for contravening Secs. 3 and 4 is a fine not exceeding £50 for a first offence; subsequent offences are misdemeanours punishable with imprisonment with hard labour for a period not exceeding six months. Sec. 5.—No person shall be liable to conviction if he can show to the satisfaction of the justice or court before whom he is charged that he was unaware of the admixture, and could not, with reasonable diligence, have ascertained it.

Sec. 6.—No person shall sell, to the prejudice of the purchaser, any article of food or any drug which is not of the nature, substance, and quality of the article demanded by such purchaser, under a penalty not exceeding £20; but no offence shall be deemed to be committed

under this section in the following cases:—(1) Where any matter or ingredient not injurious to health has been added to the food or drug because the same is required for the production or preparation thereof as an article of commerce in a state fit for carriage or consumption, and not fraudulently to increase the bulk, weight, or measure of the food or drug, or conceal the inferior quality thereof. (2) Where the drug or food is a proprietary medicine or is the subject of a patent in force, and is supplied in the state required by the specification of the patent. (3) Where the food or drug is compounded as in this Act mentioned. (4) Where the food or drug is unavoidably mixed with some extraneous matter in the process of collection or preparation.

Sec. 7.—No person shall sell any compound article of food or compounded drug which is not composed of ingredients in accordance with the demands of the purchaser, under a penalty not exceeding £20.

Sec. 8.—A drug or article of food mixed with ingredients not injurious to health may be sold if it is labelled as "mixed" at the time of sale.

Sec 9.—No person shall, with the intent that the same may be sold in its altered state without notice, abstract from an article of food any part of it so as to affect injuriously its quality, substance, or nature, and no person shall sell any article so altered without making disclosure of the alteration, under a penalty in each case not exceeding twenty pounds.

Sec. 10 deals with the appointment of analysts.

Sec. 11 empowers an analyst to perform the work of several towns or districts.

Sec. 12 gives power to any person to have food or drugs analysed by a public analyst on payment of a fee of 10*s.* 6*d.*

Sec. 13.—Any M.O.H., S.I., inspector of weights and measures, inspector of a market, or police constable charged by the S.A. with the execution of the Act, may procure samples of food and drugs and submit them to the public analyst.

Sec. 14.—Any person purchasing an article for analysis shall, after completion of the purchase, forthwith notify to the seller his intention to have the same analysed by the public analyst, and shall offer to divide the article into three parts to be then and there separated, and each part to be marked and sealed or fastened up in such manner as its nature will permit, and shall, if required to do so, proceed accordingly, and shall deliver one of the parts to the seller. He shall retain one of the three parts for future comparison, and deliver the third to the public analyst.

Sec. 15.—If the seller do not accept the offer of division, the analyst shall divide the article into two parts and seal up and deliver one of them to the purchaser, who shall retain the same for production in case proceedings shall afterwards be taken in the matter.

Sec. 16.—Samples may be sent to the analyst by "registered parcel post" if his residence is two miles from that of the purchaser.

Sec. 17.—If the seller refuse to sell to an officer of the S.A. any article of food or drug exposed for retail sale, in any premises, shop, or store, the price being tendered, and the quantity demanded not being greater than is reasonably requisite, he is liable to a penalty not exceeding £10.

Secs. 18 and 21.—The certificate of the analyst must be in a prescribed form, and is sufficient evidence of the facts therein stated, unless the defendant requires the analyst to be called as a witness.

Sec. 20.—If an offence under this Act has been committed, proceedings may be taken by the officer who took the samples. Such proceedings must be before a justice having jurisdiction in the place where the article was purchased.

Sec. 22.—The justices before whom any complaint may be made may, at the request of either party, cause any article of food or drug to be sent to the Commissioners of Inland Revenue for analysis at the Government Laboratory.

Sec. 24.—In any prosecution under this Act, where the fact of an article having been sold in a mixed state has been proved, if the defendant shall desire to rely upon any exception or provision contained in this Act, it shall be incumbent upon him to prove the same.

Sec. 25.—If the defendant proves that he sold the article in the same state as when he purchased it, and that he bought it with a written warranty that it was the same in nature, substance, and quality as that demanded by the prosecutor, he is exempt from punishment.

Sale of Food and Drugs Act Amendment Act, 1879.—This Act was passed in order to amend certain points upon which the 1875 Act was found to be insufficiently explicit.

Sec. 2.—It shall be no defence to allege that the purchaser is not prejudiced by the sale of adulterated articles, on the ground that he bought it for analysis only; or to prove that the article of food or drug, though defective in nature or in substance or in quality, was not defective in all three respects.

Sec. 3.—Any M.O.H., I.N., inspector of weights and measures, or any inspector of a market, or police constable, charged with the execution of the Act, may procure (not purchase), at the place of delivery, any sample of any milk in the course of delivery to the purchaser or consignee in pursuance of any contract for the sale to such purchaser or consignee of such milk, and may submit the sample to the Public Analyst.

Sec. 4.—Refusal to give milk for the above purpose entails a penalty not exceeding £10.

Sec. 5.—Any street or open place of public resort shall be held to come within the meaning of Sec. 17 of the principal Act.

Sale of Food and Drugs Act, 1899.—

Sec. 1.—Forbids the importation into the United Kingdom of any

of the following articles:—(*a*) Margarine, or margarine cheese, except in packages conspicuously marked "Margarine" or "Margarine Cheese" as the case may require. (*b*) Adulterated or impoverished butter (other than margarine) or adulterated or impoverished milk or cream, except in packages or cans conspicuously marked with a name or description indicating that the butter or milk or cream has been so treated. (*c*) Condensed, separated, or skimmed milk, except in tins or other receptacles which bear a label whereon the words "Machine Skimmed Milk" or "Skimmed Milk" are printed in large and legible type. (*d*) Any adulterated or impoverished article of food to which His Majesty may by Order in Council direct that this section shall be applied, unless the same be imported in packages or receptacles conspicuously marked with a name or description indicating that the article has been so treated.

Penalties—for a first offence £20; for a second £50; and a third £100.

The word "importer" shall include any person who is in possession of, or in anywise entitled to the custody or control of the article. Prosecutions shall be undertaken by the Commissioners of Customs, who when taking a sample shall divide it into three parts. When an offence has been committed the Commissioners shall notify to the Board of Agriculture the name of the importer and the place of consignment.

Sec. 2.—The L.G.B. and Board of Agriculture may procure samples for analysis. Such samples must be divided into four parts, three of which are to be dealt with as provided in Sec. 14 of the 1875 Act while the fourth part is to be sent to the Board. The result of the analysis shall be communicated to the S.A. in whose district the sample was taken, and such S.A. shall pay the analyst's fee and take all necessary proceedings.

Sec. 3.—It shall be the duty of every L.A. entrusted with the execution of the laws relating to the sale of food and drugs to carry out the provisions of the Act relating thereto. The L.G.B. may act in default of any L.A. failing to carry out the duties imposed by these Acts. The defaulting L.A. must pay the expenses.

Sec. 4.—The Board of Agriculture may make regulations for determining what deficiency in any normal constituents, or adulterations, shall raise a presumption that milk, cream, butter, and cheese is not genuine.

Sec. 5.—The provisions of the Margarine Act shall be extended to margarine cheese, and every packet containing it shall be plainly marked "Margarine Cheese".

Sec. 6.—Where under this Act or the Margarine Act, 1887, it is required that any package containing margarine or margarine cheese shall be branded or marked, the brand or mark shall be on the package itself and not solely on a label, ticket, or other thing attached thereto. When margarine or margarine cheese is sold, each wrapper must bear the letters in half-inch capital letters, and no other printed matter shall appear on the wrapper.

Sec. 7.—Every maker of margarine and margarine cheese shall keep a register as to the quantity and destination of his consignments. Officers of the Board of Agriculture have power to enter manufactories and to inspect the registers.

Sec. 8.—The fat of margarine must not contain more than 10 per cent of butter fat.

Sec. 9.—Sellers of milk or cream in any highway or place of public resort must have their name and address plainly marked upon the vehicles or cans.

Sec. 10.—When a sample of milk in course of delivery, or of margarine or margarine cheese forwarded by a public conveyance, is taken, part of the sample taken must be forwarded to the consignor if his name and address appear on the package or can.

Sec. 11.—Every tin or other receptacle containing condensed, separated or skimmed milk must bear a label clearly visible to the purchaser on which the words "Machine-skimmed Milk" or "Skimmed Milk" are printed in large and legible type. Penalty £10.

Sec. 12.—All labels referred to in Sec. 8 of the 1875 Act must be distinctly and legibly written or printed and must not be obscured by other matter on the label.

Sec. 14.—The provisions of Sec. 3 and Sec. 4 of the Sale of Food and Drugs Act Amendment Act, 1879 (relating to the taking of samples of milk in course of delivery), shall apply to every other article of food: provided that no samples shall be taken under this section except upon the request or with the consent of the purchaser or consignee.

Sec. 16.—Any person who wilfully obstructs or impedes any inspector or other officer in the course of his duties under the Sale of Food and Drugs Acts, or by any gratuity, bribe, promise, or other inducement prevents, or attempts to prevent, the due execution by such inspector or officer of his duty under those Acts, shall be liable, on summary conviction, for the first offence to a fine not exceeding twenty pounds, for the second offence to a fine not exceeding fifty pounds, and for any subsequent offence to a fine not exceeding one hundred pounds.

Sec. 18.—When any article is sold in an unopened labelled tin or packet, the seller can refuse to sell it except in the tin or packet.

Sec. 19.—No proceedings can be taken after 28 days from the date of purchase of the sample have expired. When a person is to be prosecuted the summons must state the particulars of the offence and give the name of the prosecutor. The summons shall not be made returnable in less than 14 days from the day it was served, and it must be accompanied by a copy of the analyst's certificate.

Sec. 20.—A warranty is not available as a defence unless a copy has been sent to the purchaser within seven days of the service of the summons with a written notice that reliance will be placed upon it. The name and address of the person who gave the warranty must also be

furnished. The person who gave the warranty may appear to give evidence.

Sec. 22.—When the defendant proposes to bring forward a certificate from an independent analyst, he must send such certificate to the prosecutor three clear days before the case is tried, and the prosecutor may require the presence of such analyst in court.

Sec. 25.—"Margarine cheese" means any substance, whether compound or otherwise, which is prepared in imitation of cheese, and which contains fats not derived from milk. Cheese means the substance usually known as cheese, containing no fat derived otherwise than from milk.

Sec. 26.—For the purposes of the Sale of Food and Drugs Acts the expression "food" shall include every article used for food or drink by man, other than drugs or water, and any article which ordinarily enters into or is used in the composition or preparation of human food; and shall also include flavouring matters and condiments.

Margarine Act, 1887.—"Butter" is defined as a substance made exclusively from cream or milk or both, with or without salt, or other preservative or added colouring matter. "Margarine" includes all substances, compounds or otherwise, prepared in imitation of butter, whether mixed with butter or not.

Sec. 6.—Every package containing margarine, whether closed or open, shall be plainly marked on top, bottom, and sides with the word "Margarine" in capital letters, each not less than three-quarters of an inch square. If the margarine be exposed for sale by retail, there must be attached to each parcel so exposed, a label upon which is marked in printed capital letters, clearly visible to the purchaser, the word "Margarine". The letters in this case must be each at least 1½ inches square. When retailed, margarine must always be wrapped in a paper wrapper on which is printed in capital letters the word "Margarine", each letter being not less than half an inch square.

Sec. 7.—Any person having in his possession margarine for sale contrary to the provisions of this Act shall be liable to conviction unless he can prove that he bought it as butter with a written warranty or invoice to that effect, and that he could not possibly have known that he was selling other than butter.

Sec. 9.—Manufacturers of margarine must be registered with the Authority appointing the Public Analyst of the district.

Sec. 10.—Officers authorized under the Sale of Food and Drugs Acts may take samples of butter, or substances purporting to be butter, which are exposed for sale and not marked as margarine, without going through the form of purchase required by that Act, but complying with its provisions otherwise as to dealing with samples. Such unmarked substances shall be presumed to have been exposed as butter.

Sale of Milk Regulations, 1901 (applicable to Great Britain).—The Board of Agriculture, in compliance with powers granted by Sec. 4

of the Sale of Food and Drugs Act, 1899, have issued the following regulations:—

Milk

1. Where a sample of milk (not being milk sold as skimmed, or separated, or condensed milk) contains less than 3 per cent of milk fat, it shall be presumed for the purposes of the Sale of Food and Drugs Acts, 1875–1899, until the contrary is proved, that the milk is not genuine, by reason of the extraction therefrom of milk fat, or the addition thereto of water.

2. Where a sample of milk (not being sold as skimmed, or separated, or condensed milk) contains less than 8·5 per cent of milk solids other than milk fat, it shall be presumed for the purposes of the Sale of Food and Drugs Acts, 1875–1899, until the contrary is proved, that the milk is not genuine, by reason of the abstraction therefrom of milk solids other than milk fat, or the addition thereto of water.

Skimmed or Separated Milk

3. Where a sample of skimmed or separated milk (not being condensed milk) contains less than 9 per cent of milk solids, it shall be presumed for the purposes of the Sale of Food and Drugs Acts, 1875–1899, until the contrary is proved, that the milk is not genuine, by reason of the abstraction therefrom of milk solids other than milk fat, or the addition thereto of water.

Sale of Butter Regulations, 1902 (applicable to Great Britain)

The Board of Agriculture, in exercise of powers conferred on them by Sec. 4 of the Sale of Food and Drugs Act, 1899, do hereby make the following Regulation:—

1. Where the proportion of water in a sample of butter exceeds 16 per cent, it shall be presumed for the purposes of the Sale of Food and Drugs Acts, 1875–1899, until the contrary is proved, that the butter is not genuine by reason of the excessive amount of water therein.

Taking of Samples

On page 10 is a short description of the manner of taking samples of milk under the sale of Food and Drugs Act. The same method of procedure is followed in taking samples of other articles.

Samples of butter, margarine, syrup, jams, &c., should be put into wide-mouthed bottles or jars. Other articles, such as mustard, &c., can be put into special packets made of non-absorbent material, which are sold for the purpose.

The following may be taken approximately as the quantities of substances which should be purchased for the purpose of analysis:—

Milk, 2d. worth; cream, 6d. worth; condensed milk, 3 tins; butter, cheese, jams, and honey, 1 lb.; coffee, chicory, lard, and flour, $\frac{3}{4}$ lb.; tea, cocoa, chocolate, sugar, and ginger, $\frac{1}{2}$ lb.; arrowroot and mustard, $\frac{1}{4}$ lb.; pepper, 4 oz.; bread, 1 loaf; beer, 3 pints; spirits and vinegar, 1 pint; syrup, 1 tin.

APPENDIX

Notes on Cereals, Beverages, Condiments, &c.

THE CEREALS

The starch grains or granules of the cereals possess characteristic appearances which serve to distinguish the one from the other. Thus it is possible, by examining flour, meal, &c., under the microscope, to discover the particular cereal from which it was derived, and to say whether adulteration with any other cereal has taken place.

To carry out a microscopical examination, a minute quantity of the finest ground dustlike portion of the sample should be placed on the centre of a glass slide, a drop of cold water should then be added, and the starch well mixed with it. A cover glass is now placed on the top, and the specimen is ready for examination.

For identification purposes, the starch grains of the cereals may be divided into five groups. It is not always easy to differentiate the individual members of the same group from one another, but it is usually at least possible to say to which group the cereal belongs.

The Wheat Group (*Wheat, Barley, Rye*).—The granules of this group are oval or circular in form, and have no very apparent hilum or concentric rings. The wheat granules are chiefly of two sizes—large and small—with few intermediate sizes. In the case of barley granules, intermediate sizes are more numerous, and slight concentric rings may be seen. The granules of rye are larger than the two former, and large, intermediate, and small granules are more equal in numbers. No concentric rings are visible, though a stellate hilum may occasionally be seen. Rye granules are often imperfect, and cracks frequently appear in them.

The Pea Group (*Pea, Bean, Maize*).—The granules in this group are oval or round, without evident rings, but with deep, central, longitudinal clefts. Pea granules are generally of an elongated oval shape. They have a central linear depression, which is sometimes branched. Bean granules are of a shorter oval than pea, and have an irregularly shaped and branched central depression. The granules of maize are polyhedral in shape, with a well-marked stellate hilum.

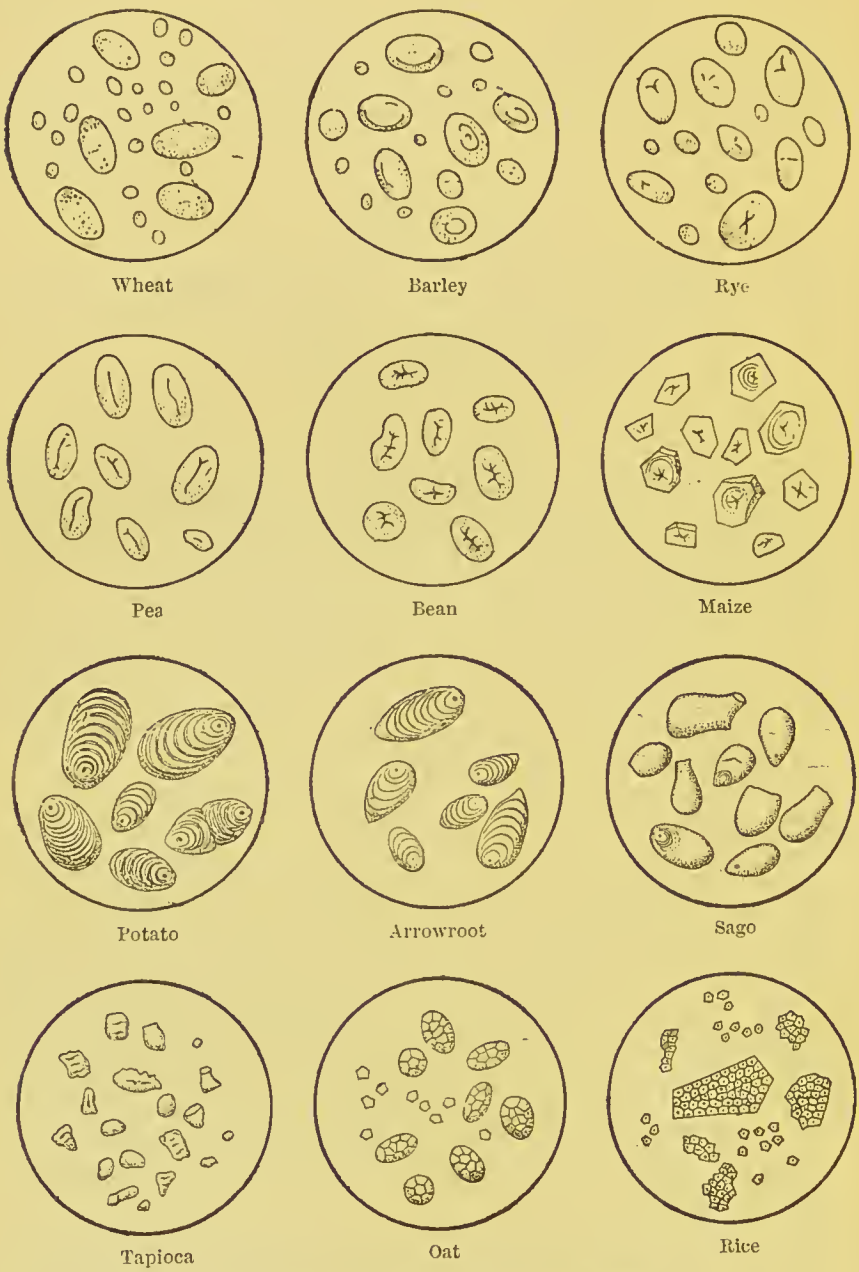


Fig. 25.—Starch Grains under the Microscope

The Potato Group (*Potato*, *Arrowroot*).—The granules of this group are large, oval or ovoid in shape, with well-marked concentric rings. Potato granules have a small but clear hilum at the narrow end,

and present an appearance not unlike an oyster. There are at least four different varieties of arrowroot, the starch granules of which vary somewhat in size and shape according to the particular variety. The hilum is generally at the broad end of the granule.

The Sago Group (*Sago*, *Tapioca*).—Irregularity of shape characterizes the granules of this group. They have a hilum and rather faint rings. Sago granules are large and irregular, sometimes rounded at one end and elongated at the other. Tapioca granules are similar but smaller.

The Oat Group (*Oat* and *Rice*).—The starch granules of this group are very small—a high power being necessary for their proper examination. The oat granules are small and many-sided. They cohere, forming round masses which are very characteristic. The granules of rice appear angular under a low power, but faceted under high powers. They form angular or irregular masses, and this distinguishes them from oat.

Parasites of Grain, Flour, Bread, &c.—These parasites may be divided into vegetable and animal:—

Vegetable Parasites—

Uredo fœtida or *Tilletia caries* (Bunt).
Uredo or *Ustilago segetum* (Smut).
Claviceps purpurea (Ergot).
Puccinia graminis (Rust).
The three Moulds—*Mucor mucedo*, *Aspergillus glaucus*, and *Penicillium glaucum*.

Uredo fœtida or *Tilletia caries* (Bunt).—This parasite is found in the interior of the grain, where its presence may not be discovered until the corn is ground into flour. If an affected grain be cut in two, it is found filled with a dark-coloured powder, possessing a disagreeable fœtid smell and a greasy feel. Under the microscope the spores appear as spherical bodies with uneven ridged surfaces.

Fig. 26.—*Ustilago segetum* (Smut) × 500

Fig. 27.—*Tilletia caries* (Bunt) × 500

Fig. 28.—Grain of Wheat affected with *Puccinia* (magnified)

Uredo or *Ustilago segetum* (Smut).—The spores of this parasite

appear as a black dusty powder on the withered heads of corn affected by it. Under the microscope the spores are seen to be small, smooth, spherical bodies, generally of a light-brown colour.

Claviceps purpurea (Ergot) is a parasite which affects rye chiefly. When it attacks this cereal the mycelium of the parasite grows rapidly, replacing the actual grain and producing ergot. Ergot grains are two to three times as large as ordinary grains of rye. They are of a dark-purple colour outside, and cream-coloured in their interior.

Life History.—If an ergot grain be placed in a moist place the sclerotium of the parasite germinates, producing outgrowths called stromata, with knoblike swellings at their distal ends. This growth is the perfect parasite, and is called *Claviceps purpurea*. If one of the knoblike heads be cut through longitudinally and examined under the microscope, it presents the appearance shown in fig. 29. A large number of oval-shaped bodies called perithecia are seen arranged round its outer surface. Each perithecium con-

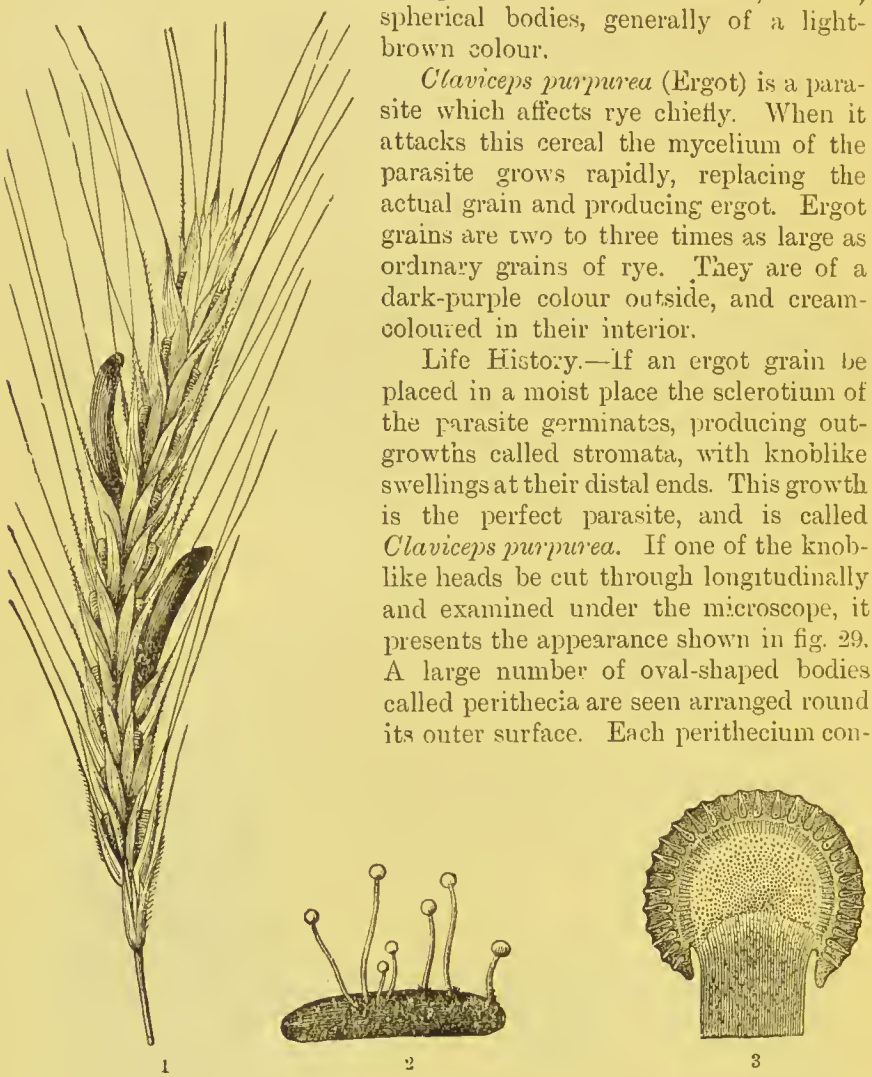


Fig. 29.—The Ergot of Rye, *Claviceps purpurea*

1, Ear of rye showing two sclerotia of the Fungus. 2, Stalked stromata arising from the sclerotium. 3, Longitudinal section through the head of a stroma showing the perithecia at the edge. 1, 2, nat. size; 3, ×40. (Partly after Tulasne.)

tains many long-shaped structures, each of which is in turn packed with eight to ten needlelike spores or sporidia. When ripe, these sporidia escape into the air and become attached to the pistil of a flower of rye. In course of time they germinate to form a sclerotium or ergot.

If ergotized rye be ground and made into bread, it may give rise to ergotism in those who consume it. Persons thus affected generally suffer from vomiting and diarrhœa, which may be followed by loss of sensibility, gangrene, or paralysis. This disease is seldom or never seen in this country. Ergot is made into a drug, and being much sought after for this purpose is rarely found in flour.

Puccinia graminis (Rust).—This parasite may attack wheat. Fig. 28 shows the microscopical appearance presented by a section through part

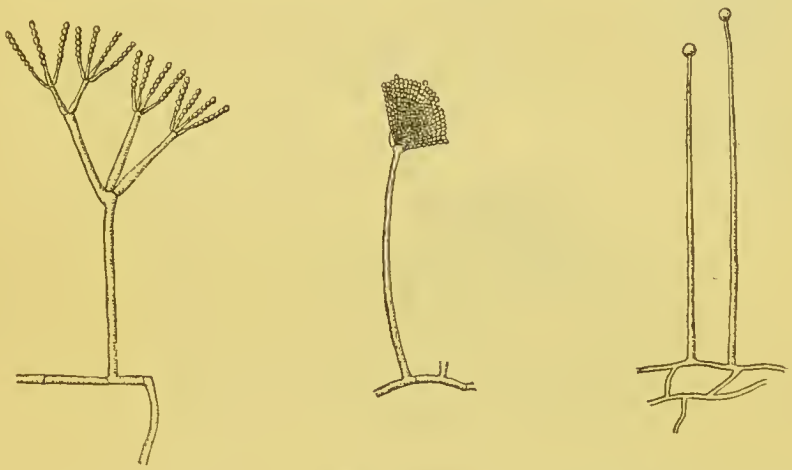


Fig. 30.—Moulds

1, Penicillium glaucum. 2, Aspergillus glaucus. 3, Mucor mucedo. (All, ×100.)

of a grain of wheat affected by it. The club-shaped teleutospores are seen growing from the surface of the grain. It is questionable whether the consumption of this parasite is injurious to health or not.

The Moulds, *Penicillium glaucum*, *Aspergillus glaucus*, and *Mucor mucedo*, may all be found as a greenish growth on damp grain, flour, bread, cheese, &c. Their microscopical appearances are shown in fig. 30.

Animal Parasites—

Acarus farinæ, or meal mite.
Calandra granaria, or corn weevil.
Bruchus pisi, or pea bruchus.
Vibrio tritici, or ear cockle.

Acarus farinæ is occasionally found in inferior meal or flour, especially if it be damp. The presence of acari may be taken as an indication that the flour is commencing to go wrong. *Calandra granaria* destroys the grain by eating the contents and leaving the shell. *Bruchus pisi*, as

its name implies, is associated with peas. *Vibrio tritici* renders the grain useless, by filling it with a cotton-like substance.

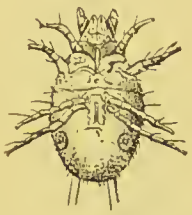


Fig. 31.—*Acarus farinæ* (magnified)

2 1

Fig. 32.—Granary Weevil (*Calandra granaria*)

1, Natural size. 2, Magnified.

2 1

Fig. 33.—Pea Beetle (*Bruchus pisi*)

1, Natural size. 2, Magnified.

Fig. 34.—*Vibrio tritici*

Nutritive Values of the Cereals.—The following table (the figures of which are taken from analyses by Kenwood and Moor and Partridge) shows the nutritive value of some of the cereals:—

	Carbohydrates.	Proteins.	Fats.	Water.	Ash.
Wheat flour ...	68·30	13·00	1·50	16·50	0·70
Barley meal ...	71·00	12·70	2·00	11·30	3·00
Oatmeal	63·00	13·00	6·00	15·00	3·00
Maize	64·50	10·00	6·70	13·50	1·40
Rye	71·25	11·00	2·00	14·00	1·75
Rice	84·40	5·00	0·10	10·00	0·50
Peas	58·00	22·60	2·00	15·60	2·40
Bean	57·50	26·25	2·50	11·50	2·25
Potato flour ...	22·85	2·00	0·15	74·00	1·00
Arrowroot ...	83·50	0·80	—	15·40	0·30
Sago	85·05	0·80	—	14·00	0·15
Tapioca	85·95	0·55	—	13·40	0·10

It will be noted that wheat is rich in proteins and carbohydrates, but poor in fat and ash. Barley contains much carbohydrates and ash, but less proteins than wheat. Oatmeal is exceptionally rich in fat and ash, but its carbohydrates are relatively low. Maize possesses a high

amount of fat. Rye is very similar to wheat in composition, while rice has a large quantity of carbohydrates, but little of anything else.

The outstanding characteristic of peas and beans is the large amounts of proteins which they contain, rendering them useful substitutes for meat. Potato flour contains a very great percentage of water, while arrowroot, sago, and tapioca are very rich in carbohydrates.

Wheat is the cereal most commonly used in Britain. A grain of wheat consists of three parts: (1) An outer protective covering called the bran. (2) The endosperm or kernel. (3) The embryo or germ of the young plant. The bran contains cellulose and mineral matter; the endosperm consists of a reticulum of cellulose filled with starch grains; while the embryo or germ is rich in protein and fat.

Flour is produced by grinding wheat. In the process of milling, the wheat grain becomes broken up. The outer envelopes yield bran, middlings, sharps, and fine pollards; the germ is removed; and the endosperm is converted into flour. Thus ordinary flour is derived entirely from the endosperm, the bran and germ being rejected. The germ is removed because it contains fat, which might become rancid, and enzymes, which by acting upon the starch of the flour tend to darken its colour. The bran, unless very finely ground, is apt to be indigestible and cause irritation of the gastro-intestinal tract. Many believe, however, that too much has in the past been sacrificed in order to obtain a very white flour, and bread made of "wholemeal flour", in which the separation of the bran is less complete, is now favoured by many.

Many patent processes of milling have recently been devised. In Smith's patent the germ is treated with steam in order to destroy its ferment, and to prevent the fat which it contains from becoming rancid. The germ is then ground fine, and 1 part of this added to 3 parts of ordinary flour constitutes "Hovis Flour". In the Frame Food process most of the mineral salts and nitrogen are extracted from the bran by boiling it with water under pressure. After evaporation and filtration the resulting extract constitutes Frame Food Extract.

Wheat flour contains from 8 to 12 per cent of gluten, and is therefore specially suited for breadmaking. (Rye also contains gluten, and can therefore be made into bread; but barley, oat, and rice, on account of the absence of this substance, are unsuitable for breadmaking.)

Adulteration of Flour.—On account of the low price of wheat at the present day there is very little adulteration of flour in this country. Adulteration might be effected by the addition of the flour of other grains, such as maize, rice, rye, oat, pea, &c. Such addition could be easily detected by the microscope.

Lolium temulentum or darnel seeds have occasionally been found in flour. They produce sickness, giddiness, delirium, and symptoms of narcotic poisoning. If alcohol be added to flour containing lolium, a greenish solution with a very unpleasant taste is produced; when added to ordinary flour, a yellowish solution with a pleasant taste results.

Inspection of Flour.—Good flour should be white in colour (this quality depends somewhat upon the amount of bran which it contains). It ought to be free from odour and possess no acidity. Old or spoiled flour is generally yellow in colour and has an acid reaction.

Bread is made by mixing together wheat flour, a little salt and water, and kneading it, so as to form dough by the cohesion of the moistened gluten. The dough is next charged with carbonic acid gas, which by occupying innumerable little spaces or lacunæ renders the mass porous. The carbonic acid is derived in one of three ways: (1) By the addition of yeast, which sets up a fermentation resulting in the formation of alcohol and carbonic acid gas. (2) By the use of baking powders containing dry alkaline carbonates, mixed with tartaric or other acid, which on being moistened give off carbonic acid. (3) By kneading the dough with water charged with carbonic acid gas under pressure ("aerated" bread).

Bread should be white. A yellow or dark colour may be due to old or inferior flour, bad yeast, admixture with rye, &c. It must be remembered, however, that wholemeal bread is not very white in colour. Acidity should not be prescnt, it being generally due to old or inferior flour.

Biscuits.—The term biscuit literally means twice baked, but this definition is not applicable to the majority of biscuits now made. The chief difference between biscuits and bread lies in the fact that they are not permeated with little cavities. Biscuits contain less water, but a larger proportion of carbohydrate and protein than bread. They are therefore more nutritious than bread and are more easily carried about.

SUGAR

Sugar may either be obtained from the sugar cane or from the beetroot. The appearance of sugar depends much upon its purity. Thus there are many different grades, from the brown or "moist" sugars to the pure white "loaf sugar" or white crystals. Generally speaking the whiter the sugar the less water does it contain.

BEVERAGES

Beverages may for convenience of description be divided into two classes — alcoholic and non-alcoholic. We shall deal with the non-alcoholic first.

Non-alcoholic Beverages

Tea consists of the dried leaves of the *Camellia Thea*, a shrub which grows in China, India, Ceylon, and Japan. Black and green teas are derived from the same plant, the difference in colour being due to the mode of preparation. Teas are often classified according to the age

of the leaf, the resulting crops being known as Orange Pekoe, Pekoe, Pekoe Souchong, Souchong, &c.

The tea leaf has a characteristic shape and structure. It is oval with a serrated border — the serrations extend nearly but not quite down to the point of attachment of the stalk. The primary veins run out from the midrib, but turn inwards before the border is reached, so that a distinct space is left between them and the border. Tea leaves when met with in the ordinary state are dried and curled. If put into hot water they uncurl, when their structure may be made out. The leaves of the sloe, willow, oak, &c., are said to have been substituted for tea, but such adulteration is now little practised.

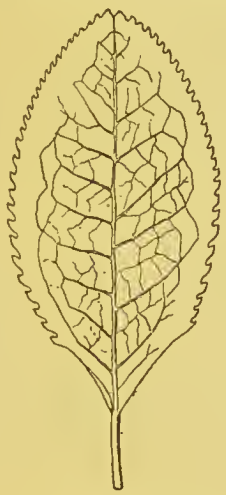
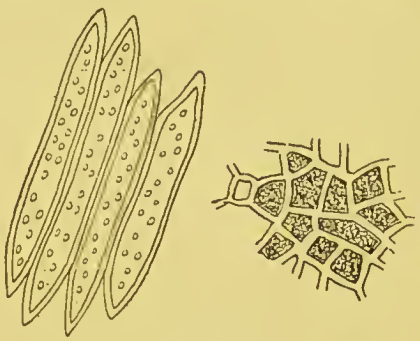
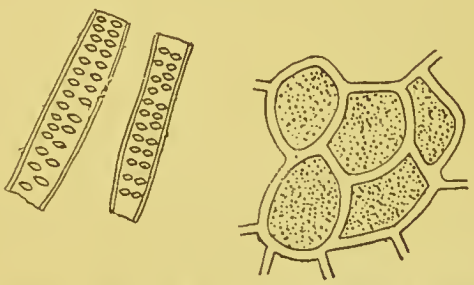


Fig. 35.—Tea Leaf (magnified)



Coffee (×200): Oval Cells of Testa and Cellular Structure



Chicory (×200,: Dotted Ducts and Cellular Structure

Fig. 36

Exhausted tea leaves are sometimes dried and mixed with gum or catechu and sold as sound tea. Tea should have a pleasant aroma when dry, and a fragrant smell when infused. The infusion should not be too dark in colour, nor should it possess a bitter taste.

The chief constituents of tea are tannin, an aromatic oil, and an alkaloid called thein. Tea taken in moderation acts as a nervous stimulant and restorative in fatigue.

Coffee is the seed or berry of the *Caffea arabica*, a plant which grows in the tropics. The seeds are first roasted until they assume a chocolate-brown colour, after which they are ground in a mill into coffee. The chief properties of coffee are dependent upon an aromatic

oil and an alkaloid called caffein which it contains. An infusion of coffee stimulates the nervous system and removes the sensation of fatigue.

The chief adulterant of coffee is chicory, but maize, dates, beans, &c., have also been used. Spurious coffee beans have been moulded from a composition consisting of chicory and other adulterants. Chicory may be legally added to coffee provided such admixture is stated. When thrown into cold water, chicory sinks rapidly and colours the liquid brown, whereas coffee floats and imparts no colour to water.

The surest method of discovering the presence of chicory in coffee is, however, by microscopical examination. The long oval cells of the coffee berry with their irregular cross markings are characteristic. The internal structure of the berry consists of an irregular network of fibres, forming a cellular structure containing dark angular masses and oil globules. Chicory has a coarser areolar tissue and long dotted ducts.

Cocoa is the seed of the *Theobroma Cacao*, which grows chiefly in the West Indies. When the seeds or beans are roughly broken, the name cocoa nibs is applied to them. Cocoa contains a large percentage of fat, part of which is generally removed in its manufacture. It also contains theobromine, which is an alkaloid very similar to thein of tea and caffein of coffee. If cocoa be adulterated at all, it is generally by the addition of sugar and starch, which can be detected by the microscope.

Chocolate is a preparation of cocoa from which the fat may or may not have been removed. After being mixed with sugar and flavouring agents it is made into a paste with water and then pressed in moulds.

Lemon and lime juice are expressed from their respective fruits. They contain vegetable acids, chiefly citric and a little malic acid. They are often mixed with water, and sometimes with sulphuric, tartaric, or other acid. They are most useful in the prevention of scurvy.

Alcoholic Beverages

When yeast is added to grape sugar, at a suitable temperature, it splits it up into alcohol and carbonic acid gas—

$$C_6H_{12}O_6 = 2C_2H_6O + 2CO_2.$$

Beer used to be made from malt and hops only. At the present day, however, glucose and invert sugar are much used instead of malt, and various vegetable bitters, such as quassia, are frequently substituted for hops. Thus beer may now be defined as—a fermented saccharine infusion to which a wholesome bitter has been added. Glucose and invert sugars are generally obtained by the action of sulphuric acid on rice or other starches. Commercial sulphuric acid contains a considerable amount of arsenic. This fact was responsible for an outbreak of arsenical poisoning among beer drinkers in England in 1900–1. Arsenic

may also occur in beer owing to the use of arsenical fuel in the drying of the malt and hops.

The best beers are still made from malt and hops, and are prepared as follows. The barley is moistened and kept in a warm place till it begins to germinate. During this process the ferment "diastase" is developed. It acts upon the starch of the grain, converting some of it into sugar. All further germination is then arrested by drying the barley over a kiln, thus converting it into "malt". The malt is next subjected to "mashing", by being crushed and then placed in a mash tub with warm water at about 160° F. During this process the diastase acts further upon the starch, converting most of it into the sugar maltose. This infusion or "wort", after being clarified, is boiled with hops. It is then cooled to a suitable temperature for fermentation and run into a fermenting tun, where a sufficient quantity of yeast is added to it. By the action of the latter the sugar splits up into alcohol, which remains in the beer, and carbonic acid gas, which for the most part escapes into the air.

Beers or porters which contain less than 3 per cent of alcohol and 4 per cent of extract may be looked upon as weak, and are unlikely to keep well. In a good beer the alcohol and extract should be each 4 per cent. Beer may be adulterated by the addition of water or salt, the latter being added for the purpose of causing thirst and a craving for more drink.

Spirits.—The common spirits sold in Britain are—brandy, whisky, rum, and gin. All contain ethylic alcohol mixed with water. They also contain other alcohols, various compound ethers, and aromatic bodies, produced during distillation, which give to each their characteristic taste and aroma. Spirits generally contain about 50 per cent of alcohol.

Brandy is made by distilling fermented grape juice. Many so-called brandies are mere imitations of the true material made from corn spirit suitably flavoured and coloured. Such imitations, sold when brandy is asked for, constitute an infringement of the Sale of Food and Drugs Act.

Whisky is made by the distillation of malted grain. It may be produced either in a pot still or in a patent still. Patent-still whisky contains few secondary products, these being got rid of by means of fractional distillation in the patent still. Pot-still whisky contains many secondary products, which are supposed by some to increase the therapeutic value of the spirit. New whisky (especially pot-still) contains fusel oil, which, if present in any quantity, causes rapid intoxication followed by headache and depression.

Rum is distilled from fermented molasses.

Gin is generally made from a mixture of malt and barley flavoured with juniper berries, oil of turpentine, orange peel, and other aromatic substances.

Wine may be defined as "the fermented juice of the grape, with such additions only as are essential to the stability or keeping qualities of the wine".

When the juice of the grape is kept at a moderate temperature, fermentation takes place. This fermentation is produced by germs, which adhere to the skin of the grapes, and are introduced into the "must" or grape juice on pressing the grapes. As a result of fermentation the sugar of the juice is converted into alcohol.

Wines vary much in composition. The lighter wines, Bordeaux, Rhine wines, Burgundies, Champagnes, and Moselles, generally contain from 10 to 15 per cent of alcohol by volume. The stronger wines, Sherry, Port, and Madeira, may contain from 15 to 25 per cent of alcohol. Apart from alcohol, wines also contain compound ethers (which are responsible for the bouquet of the wine), albuminous and colouring matters, and vegetable acids, such as tannic acid, &c.

Wine may be adulterated by the addition of colouring agents, ether, alum, &c. To increase the dryness of wines "plastering" is sometimes resorted to. In this process plaster of Paris or sulphate of lime is added to the wine. It clears the wine, making it look brilliant, but is injurious, owing to the formation of potassium sulphate, which has a purgative action on consumers.

Absolute alcohol is pure spirit free from water. When mixed with 10 per cent by volume of water it is called rectified spirit; and when mixed with 42·95 per cent volume in volume of water it constitutes proof spirit.

CONDIMENTS

Vinegar.—There are several different kinds of vinegar, the most common being Malt Vinegar and Wine Vinegar. The two latter are made by acetous fermentation of malt, or white wine, respectively. Inferior vinegars made from unmalted barley, maize, rice, and other grains, or from molasses or sugar, are frequently sold as malt vinegar.

Vinegar may be adulterated with water, mineral acids, especially sulphuric, and by metals, such as copper, arsenic, &c. It is unfortunate that small quantities of sulphuric acid are allowed to be added to English vinegar.

Mustard may be adulterated by admixture with various starches or turmeric. **Pepper** may be adulterated with linseed, wheat, and pea flour, ground rice, &c.

INDEX

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